

Background Document D:
Material Safety Data Sheets (MSDS)
Utah Chemical Agent Rule (UCAR)

May 1999

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BACKGROUND DOCUMENT D:
MATERIAL SAFETY DATA SHEETS (MSDS)

INTRODUCTION AND TABLE OF CONTENTS

This background document provides up-to-date Material Safety Data Sheets for proposed chemical agent related hazardous constituents. Following is the Table of Contents, which is arranged by the chemical synonym:

GB, Sarin
GD, Soman
GA, Tabun
GF
VX
H, HD, Mustard
L, L1, Lewisite
HN1
HN3
HL
HQ
HT
DM, Adamsite
Q, Q-Mustard
T, T-Mustard
EA-2192
LO, Lewisite Oxide
CK
CG
BZ
Vx (See VX)
L2, Lewisite 2 (See L1)
L3, Lewisite 3 (See L1)

MSDS for HF and chloroform are not included in this background document because these are fairly common industrial chemicals. In addition, MSDSs could not be located for L2, L3, or Vx. Because of the similarity of L2 and L3 to L1, the MSDS for L1 can be referenced for information on L2 and L3. Because of the similarity of Vx to VX, the MSDS for VX can be examined for information on Vx.

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MATERIAL SAFETY DATA SHEET

LETHAL NERVE AGENT (GB)



SECTION I - GENERAL INFORMATION

DATE: 14 September 1988
REVISED: 28 February 1996

MANUFACTURER'S ADDRESS:

U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423

Emergency telephone #'s: 0700-1630 EST: 410-671-4411/4414
After: 1630 EST: 410-278-5201, Ask for Staff Duty Officer

CAS REGISTRY NUMBERS: 107-44-8, 50642-23-4

CHEMICAL NAME:

Isopropyl methylphosphonofluoridate

ALTERNATE CHEMICAL NAMES:

O-Isopropyl Methylphosphonofluoridate

Phosphonofluoridic acid, methyl-, isopropyl ester

Phosphonofluoridic acid, methyl-, 1-methylethyl ester

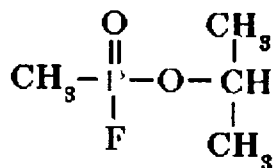
TRADE NAME AND SYNONYMS:

Isopropyl ester of methylphosphonofluoridic acid
Methylisopropoxfluorophosphine oxide
Isopropyl Methylfluorophosphonate
O-Isopropyl Methylisopropoxfluorophosphine oxide
Methylfluorophosphonic acid, isopropyl ester
Isopropoxymethylphosphonyl fluoride
Isopropyl methylfluorophosphate
Isopropoxymethylphosphoryl fluoride
GB
Sarin
Zarin

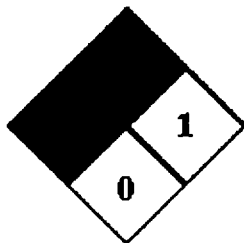
CHEMICAL FAMILY: Fluorinated organophosphorous compound

FORMULA/CHEMICAL STRUCTURE:

C4H10FO2P



NFPA 704 HAZARD SIGNAL:



Health - 4
Flammability - 1
Reactivity - 1
Special - 0

SECTION II - HAZARDOUS INGREDIENTS

<u>INGREDIENTS NAME</u>	<u>FORMULA</u>	<u>PERCENTAGE BY WEIGHT</u>	<u>AIRBORNE EXPOSURE LIMIT (AEL)</u>
GB	C4H10FO2P	100	0.0001 mg/m3

SECTION III - PHYSICAL DATA

BOILING POINT: 158 C (316 F)

VAPOR PRESSURE (mm Hg): 2.9 @ 25 C

VAPOR DENSITY (AIR=1): 4.86

SOLUBILITY: Miscible with water. Soluble in all organic solvents.

SPECIFIC GRAVITY (H2O=1): 1.0887 @ 25 C

FREEZING/MELTING POINT: -56 C

LIQUID DENSITY (g/cc):

1.0887 @ 25 C
1.102 @ 20 C

PERCENTAGE VOLATILE BY VOLUME:

22,000 m/m3 @ 25 C
16,090 m/m3 @ 20 C

APPEARANCE AND ODOR: Colorless liquid. Odorless in pure form.

SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT (METHOD USED): Did not flash to 280 F



FLAMMABLE LIMIT: Not applicable

LOWER EXPLOSIVE LIMIT: Not available

UPPER EXPLOSIVE LIMIT: Not available

EXTINGUISHING MEDIA: Water mist, fog, foam, CO2.

Avoid using extinguishing methods that will cause splashing or spreading of the GB.

SPECIAL FIRE FIGHTING PROCEDURES: GB will react with steam or water to produce toxic and corrosive vapors. All persons not engaged in extinguishing the fire should be evacuated. Fires involving GB should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighting protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing (See Section VIII).



Do not breathe fumes. Skin contact with nerve agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with the agent liquid or vapor can be fatal.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Hydrogen may be present.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMITS (AEL): The permissible airborne exposure concentration for GB for an 8-hour workday or a 40-hour work week is an 8-hour time weighted average (TWA) of 0.0001 mg/m3. This value is based on the TWA of GB which can be found in "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX." To date, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for GB.

GB is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

EFFECTS OF OVEREXPOSURE: GB is a lethal cholinesterase inhibitor. Doses that are potentially life threatening may be only slightly larger than those producing least effects.

GB

<u>Route Dosage</u>	<u>Form</u>	<u>Effect</u>	<u>Type</u>
ocular	vapor	ECt50	<2 mg-min/m3
inhalation	vapor	ECt50	<2 mg-min/m3
inhalation (15 l/min)	vapor	ICt50	35 mg-min/m3
inhalation	vapor	LCt50	70 mg-min/m3
percutaneous	liquid	LD50	1700 mg/70 kg man

Effective dosages for vapor are estimated for exposure durations of 2-10 minutes.

Symptoms of overexposure may occur within minutes or hours, depending upon dose. They include: miosis (constriction of pupils) and visual effects, headaches and pressure sensation, runny nose and nasal congestion, salivation, tightness in the chest, nausea, vomiting, giddiness, anxiety, difficulty in thinking and sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps, diarrhea, involuntary urination and defecation. With severe exposure symptoms progress to convulsions and respiratory failure.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by physician).



Injectors using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

EYE CONTACT: Immediately flush eyes with water for at least 15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to a medical treatment facility for observation.

SKIN CONTACT: Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminant. Administer Nerve Agent Antidote Kit(s), MARK I injectors only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.

INGESTION: Do not induce vomiting. First symptoms are likely to be gastrointestinal. IMMEDIATELY administer Nerve Agent Antidote Kit(s), MARK I injector(s). Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable when pure.

INCOMPATIBILITY: Attacks tin, magnesium, cadmium plated steel, and some aluminum. Slightly attacks copper, brass, and lead; practically no attack on 1020 steels, Inconel & K-monel.

HAZARDOUS DECOMPOSITION: Hydrolyzes to form HF under acid conditions and isopropyl alcohol & polymers under basic conditions.

HAZARDOUS POLYMERIZATION: Does not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If leaks or spills occur, only personnel in full protective clothing will remain in area (**See Section VIII**). In case of personnel contamination see **Section V** for emergency and first aid instructions.

RECOMMENDED FIELD PROCEDURES: Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. Decontaminate with copious amounts of aqueous sodium hydroxide solution (a minimum 10 wt. %). Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and then labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (**See Sections II and VIII**).

If 10 wt.% aqueous sodium hydroxide solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Agent, DS (DS2), Sodium Carbonate, and Supertropical Bleach Slurry (STB).

RECOMMENDED LABORATORY PROCEDURES: A minimum of 56 grams of decon solution is required for each gram of GB. Decontaminant and agent solution is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour. At the end of the hour, the resulting solution should be adjusted to a pH greater than 11.5. If the pH is below 11.5, NaOH should be added until a pH above 11.5 can be maintained for 60 minutes. An alternate solution for the decontamination of GB is 10 wt.% sodium carbonate in place of the 10% sodium hydroxide solution above. Continue with 56 grams of decon for each gram of agent. Agitate for one hour but allow three hours for the reaction. The final pH should be adjusted to above zero. It is also permitted to substitute 5.25% sodium hypochlorite or 25 wt. % Monoethylamine (MEA) for the 10% sodium hydroxide solution above. MEA must be completely dissolved in water before addition of the agent. Continue with 56 grams of decon for each gram of GB and provide agitation for one hour. Continue with same ratios and time stipulations. Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and then labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of according to waste disposal methods provided below. Dispose of decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (**See Sections II and VIII**).

WASTE DISPOSAL METHOD: Open pit burning or burying of GB or items containing or



contaminated with GB in any quantity is prohibited. The detoxified GB (using procedures above) can be thermally destroyed by incineration in EPA approved incinerators according to appropriate provisions of Federal, state and local Resource Conservation and Recovery Act (RCRA) Regulations.

NOTE: Some states define decontaminated surety material as an RCRA Hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

<u>CONCENTRATION</u>	<u>RESPIRATORY PROTECTIVE EQUIPMENT.</u>
< 0.0001 mg/m ³	A full face piece, chemical canister, air purifying protective mask will be on hand for escape. (The M9-, M17-, or M40-series masks are acceptable for this purpose. Other masks certified as equivalent may be used)
> 0.0001 or =0.2 mg/m ³	A NIOSH/MSHA approved pressure demand full face piece SCBA or supplied air respirators with escape air cylinder may be used. Alternatively, a full face piece, chemical canister air-purifying protective mask is acceptable for this purpose (See DA PAM 385-61 for determination of appropriate level)
>0.2 or unknown mg/m ³	NIOSH/MSHA approved pressure demand full face piece SCBA suitable for use in high agent concentrations with protective ensemble (See DA PAM 385-61 for examples)

VENTILATION:

Local Exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentration to < 0.0001 mg/m³. Air emissions will meet local, state and federal regulations.

Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (lfpm) +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke producing devices will be performed in the assessment of the hoods ability to contain agent GB.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection is allowed between agent areas and other areas through the ventilation system. Emergency backup power is necessary. Hoods should be tested at least semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hood face.

PROTECTIVE GLOVES:

Butyl Rubber Glove M3 and M4
Norton, Chemical Protective Glove Set

EYE PROTECTION: As a minimum chemical goggles will be worn. For splash hazards use goggles and face shield.

OTHER PROTECTIVE EQUIPMENT: For general lab work, gloves and lab coat will be worn with mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.

MONITORING: Available monitoring equipment for agent GB is the M8/M9 Detector paper, detector ticket, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAAMS), Automatic Continuous Air Monitoring System (ACAMS), real time monitoring (RTM), Demilitarization Chemical Agent Concentrator (DCAC), M8/M43, M8A1/M43A2, Hydrogen Flame Photometric Emission Detector (HYFED), CAM-M1, Miniature Chemical Agent Monitor (MINICAM) and the Real Time Analytical Platform (RTAP).

Real-time, low-level monitors (with alarm) are required for GB operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When handling agents, the buddy system will be incorporated. No smoking, eating and drinking in areas containing agents are permitted. Containers should be periodically inspected for leaks either visually or by a detector kit). Stringent control over all personnel



practices must be exercised Decontamination equipment will be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap and water before leaving at the end of the work day.

OTHER PRECAUTIONS: GB must be double contained in liquid and vapor tight containers when in storage or outside a ventilation hood.

For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety Program," "DA PAM 385-61, Toxic Chemical Agent Safety Standards," and "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX."

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.

DOT HAZARD CLASSIFICATION: 6.1, Packing Group I,

Hazard Zone A

DOT LABEL: Poison

DOT MARKING: Poisonous liquid, n.o.s. (Isopropyl methylphosphonofluoridate) UN2810, Inhalation Hazard

DOT PLACARD: Poison



EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

While the Edgewood Research Development, and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development, and Engineering Center assume legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of this data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.



MATERIAL SAFETY DATA SHEET

LETHAL NERVE AGENT (GD)



SECTION I - GENERAL INFORMATION

DATE: 14 September 1988
REVISED: 28 February 1996

MANUFACTURER'S ADDRESS:

U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423

Emergency telephone #'s: 0700-1630 EST: 410-671-4411/4414
After: 1630 EST: 410- 278-5201, Ask for Staff Duty Officer

CAS REGISTRY NUMBERS: 96-64-0, 50642-24-5

CHEMICAL NAME:

Pinacolyl methyl phosphonofluoridate

ALTERNATE CHEMICAL NAMES:

Phosphonofluoridic acid, methyl-,1,2,2-trimethylpropyl ester
O-Pinalcolyl methylphosphonofluoridate

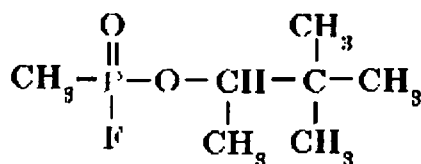
TRADE NAME AND SYNONYMS:

3,3 dimethyl-n-but-2-yl methylphosphonofluoridate
1,2,2-Trimethylpropyl methylphosphonofluoridate
Methylpinacolyl oxyfluorophosphine oxide
Pinacolyl oxymethylphosphonyl fluoride
Pinacolyl methanefluorophosphonate
Methylfluoropinacolylphosphonate
Fluoromethylpinacolyl oxyphosphine oxide
Methylpinacolyl oxyphosphonyl fluoride
Pinacolyl methylfluorophosphonate
1,2,2-Trimethylpropoxyfluoromethylphosphine oxide
GD
EA 1210
Soman
Zoman
PFMP

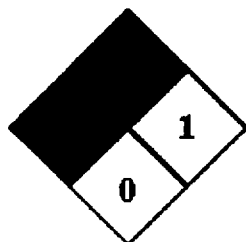
CHEMICAL FAMILY: Fluorinated organophosphorous compound

FORMULA/CHEMICAL STRUCTURE:

C7H16FO2P



NFPA 704 SIGNAL:



Health - 4
 Flammability - 1
 Reactivity - 1
 Special - 0

SECTION II - HAZARDOUS INGREDIENTS

<u>INGREDIENTS NAME</u>	<u>FORMULA</u>	<u>PERCENTAGE BY WEIGHT</u>	<u>AIRBORNE EXPOSURE LIMIT (AEL)</u>
GD	C7H16FO2P	100	0.00003 mg/m3

SECTION III - PHYSICAL DATA

BOILING POINT: 198 C (388 F)

VAPOR PRESSURE: 0.40 mm Hg @ 25 C

VAPOR DENSITY (AIR=1): 6.33

SOLUBILITY: 2.1 percent at 20 C and 3.4 percent at 0 C in water. Soluble in sulfur mustard, gasoline, alcohols, fats, and oils.

SPECIFIC GRAVITY (H2O=1): 1.022 @ 25 C

FREEZING/MELTING POINT: -42C

LIQUID DENSITY (g/cc): 1.0222 @ 25 C

PERCENTAGE VOLATILE BY VOLUME: 3900 mg/m3 @ 25 C

APPEARANCE AND ODOR: When pure, colorless liquid with a fruity odor. With impurities, amber or dark brown with oil of camphor odor.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: 121 C (Open cup)

FLAMMABLE LIMIT: Unknown

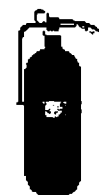


LOWER EXPLOSIVE LIMIT: Not available

UPPER EXPLOSIVE LIMIT: Not available

EXTINGUISHING MEDIA: Water mist, fog, foam, CO2. Avoid using extinguishing methods that will cause splashing or spreading of the GD.

SPECIAL FIRE FIGHTING PROCEDURES: GD will react with steam or water to produce toxic & corrosive vapors. All persons not engaged in extinguishing the fire should be evacuated. Fires involving GD should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighting protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing (See Section VIII).



Do not breathe fumes. Skin contact with nerve agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with the agent liquid or vapor can be fatal.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Hydrogen produced by the corrosive vapors reacting with metals, concrete, etc., may be present.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMITS (AEL): The permissible airborne exposure concentration for GD for an 8-hour workday or a 40-hour work week is an 8-hour time weighted average (TWA) of 0.00003 mg/m3. This value is based on the TWA of GD which can be found in "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX." To date, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for GD.

GD is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

EFFECTS OF OVEREXPOSURE: GD is a lethal cholinesterase inhibitor. Doses that are potentially life threatening may be only slightly larger than those producing least effects.

GD

<u>Route</u>	<u>Form</u>	<u>Effect</u>	<u>Type</u>	<u>Dosage</u>
ocular	vapor	miosis	ECt50	<2 mg-min/m ³
inhalation	vapor	runny nose	ECt50	<2 mg-min/m ³
inhalation (15 l/min)	vapor	severe incapacitation	ICt50	35 mg-min/m ³
inhalation (15 l/min)	vapor	death	LCt50	70 mg-min/m ³
percutaneous	liquid	death	LD50	350 mg/70 kg man

Effective dosages for vapor are estimated for exposure durations of 2-10 minutes.

Symptoms of overexposure may occur within minutes or hours, depending upon dose. They include: miosis (constriction of pupils) and visual effects, headaches and pressure sensation, runny nose and nasal congestion, salivation, tightness in the chest, nausea, vomiting, giddiness, anxiety, difficulty in thinking and sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps, diarrhea, involuntary urination and defecation. With severe exposure symptoms progress to convulsions and respiratory failure.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.



EYE CONTACT: Immediately flush eyes with water for at least 15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to a medical treatment facility for observation.

SKIN CONTACT: Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove

decontaminant. Administer Nerve Agent Antidote Kit(s), MARK I injectors only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.

INGESTION: Do not induce vomiting. First symptoms are likely to be gastrointestinal.

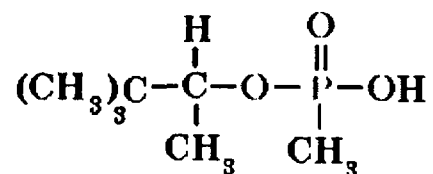
IMMEDIATELY administer Nerve Agent Antidote Kit(s), MARK I injector(s). Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable after storage in steel for three months at 65 C.

INCOMPATIBILITY: GD corrodes steel at the rate of 1 x 10⁻⁵ inch/month.

HAZARDOUS DECOMPOSITION: GD will hydrolyze to form HF and



HAZARDOUS POLYMERIZATION: Does not occur.

SECTION VII - SPILL, LEAK AND DISPOSAL METHODS

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If leak or spills occur, only personnel in full protective clothing (**See Section VIII**) will remain in area. In case of personnel contamination see **Section V** for emergency and first aid instructions.

RECOMMENDED FIELD PROCEDURES: Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. Decontaminate with copious amounts of aqueous Sodium Hydroxide solution (a minimum 10 wt.%). Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and then labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (**See Sections II and VIII**).

If 10 wt.% aqueous sodium hydroxide solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Agent, DS (DS2), Sodium Carbonate, and Supertropical Bleach Slurry (STB).

RECOMMENDED LABORATORY PROCEDURES: A minimum of 55 grams of decon solution is required per gram of GD. Decontaminant/agent solution is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour provided a single phase is obtained. At the end of the first hour the pH should be checked and adjusted up to 11.5 with additional NaOH as required. An alternate solution for the decontamination of GD is 10% sodium carbonate in place of the 10% Sodium Hydroxide solution above. Continue with 55 grams of decon per gram of GD. Agitate for one hour and allow to react for three hours. At the end of the third hour adjust the pH to above 10. It is also permitted to substitute 5.25 % sodium hypochlorite for the 10% sodium hydroxide solution above. Continue with 55 grams of decon per gram of GD. Agitate for one hour and allow to react for three hours then adjust the pH to above 10. Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (**See Sections II and VIII**).

WASTE DISPOSAL METHOD: Open pit burning or burying of GD or items containing or



contaminated with GD in any quantity is prohibited. The detoxified GD (using procedures above) can be thermally destroyed by incineration in EPA approved incinerators according to appropriate provisions of Federal, state and local Resource Conservation and Recovery Act (RCRA) regulations.

NOTE: Some states define decontaminated surety material as a RCRA Hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

CONCENTRATION

RESPIRATORY PROTECTIVE EQUIPMENT

< 0.00003 mg/m³

A full face piece, chemical canister, air-purifying protective mask will be on hand for escape. (The M9-, M17-, or M40-series masks are acceptable for this purpose. Other masks certified as equivalent may be used).

>0.00003 to 0.06 mg/m³

A NIOSH/MSHA approved pressure demand full face piece SCBA or supplied air respirators with escape air cylinder may be used. Alternatively, a full face piece, chemical canister air-purifying protective mask is acceptable for this purpose (See DA PAM 385-61 for determination of appropriate level)

0.06 mg/m³ or unknown

NIOSH/MSHA approved pressure demand full face piece SCBA suitable for use in high agent concentrations with protective ensemble (See DA PAM 385-61 for examples).

VENTILATION:

Local Exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentration to < 0.00001 mg/m³. Air emissions will meet local, state and federal regulations.

Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (lfpm) +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke producing devices will be performed in the assessment of the hood's ability to contain agent GD.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection is allowed between agent areas and other areas through the ventilation systems. Emergency backup power is necessary. Hoods should be tested at least semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hood face.

PROTECTIVE GLOVES:

**Butyl Rubber Glove M3 and M4
Norton, Chemical Protective Glove Set**

EYE PROTECTION: As a minimum chemical goggles will be worn.

For splash hazards use goggles and face shield.

OTHER PROTECTIVE EQUIPMENT: For general lab work, gloves and lab coat will be worn with mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.

MONITORING: Available monitoring equipment for agent GD is the M8/M9 Detector paper, detector ticket, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAAMS), Automatic Continuous Air Monitoring System (ACAMS), real time monitoring (RTM), Demilitarization Chemical Agent Concentrator (DCAC), M8/M43, M8A1/M43A2, Hydrogen Flame Photometric Emission Detector (HYFED), CAM-M1, Miniature Chemical Agent Monitor (MINICAM) and the Real Time Analytical Platform (RTAP).

Real-time, low-level monitors (with alarm) are required for GD operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When handling agents, the buddy system will be incorporated. No smoking, eating and drinking in areas containing agents is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel



practices must be exercised. Decontamination equipment will be conveniently placed. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap and water before leaving at the end of the work day.

OTHER PRECAUTIONS: GD must be double contained in liquid and vapor tight containers when in storage or when outside a ventilation hood.

For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety

Program," "DA PAM 385-61, Toxic Chemical Agent Safety Standards," and "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX."

SECTION X - TRANSPORTATION DATA


PROPER SHIPPING NAME: Poisonous liquids, n.o.s.

DOT HAZARD CLASSIFICATION: 6.1, Packing Group I, Hazard Zone B

DOT LABEL: Poison

DOT MARKING: Poisonous liquids, n.o.s. (Pinacolyl methyl phosphonofluoridate)

UN 2810, Inhalation Hazard

DOT PLACARD: POISON  align=top src="/RDA/erdec/risk/safety/graphics/dot_pois.gif" hspace=100 vspace=0>

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See **Sections IV, VII and VIII.**

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

While the Edgewood Research Development, and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development, and Engineering Center assume legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of this data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws regulations.

ADDENDUM A: ADDITIONAL INFORMATION FOR THICKENED GD

TRADE NAME AND SYNONYMS: Thickened GD, TGD.

HAZARDOUS INGREDIENTS: K125 (an acryloid copolymer, 5%) is used to thicken the GD. K125 is not known to be a hazardous material except in a finely-divided, powder form.

PHYSICAL DATA: Essentially the same as GD except for viscosity. The viscosity of TGD is approximately 1180 centistoke.

FIRE AND EXPLOSION DATA: Same as GD.

HEALTH HAZARD DATA: Same as GD except for skin contact. For skin contact, don respiratory protective mask and remove contaminated clothing. Immediately scrape the TGD from the skin surface, then wash the contaminated surface with acetone. Administer Nerve Agent Antidote Kit, MARK I, only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.

SPILL, LEAK AND DISPOSAL PROCEDURES: If spills or leaks of TGD occur, follow the same procedure as those for GD, but add the following step: Since TGD is not water soluble, dissolve the TGD in acetone before introducing any decontaminating solution. Containment of TGD is generally not necessary. Spilled TGD can be carefully scraped off the contaminated surface and placed in a DOT approved container. The TGD can then be decontaminated after it has been dissolved in acetone, using the same procedures as for GD. Contaminated surfaces should be treated with acetone, then decontaminated using the same procedures as for GD.

SPECIAL PROTECTION INFORMATION: Same as GD.

SPECIAL PRECAUTIONS: Same as GD with the following addition: Handling the TGD requires careful observation of the "stringers" (elastic, thread like attachments) formed when the agents are transferred or dispensed. These stringers must be broken cleanly before moving the contaminating device or dispensing device to another location, or unwanted contamination of a working surface will result.

TRANSPORTATION DATA: Same as GD.



MATERIAL SAFETY DATA SHEET

LETHAL NERVE AGENT (GA)



SECTION I - GENERAL INFORMATION

DATE: 14 September 1988
REVISED: 28 February 1996

MANUFACTURER'S ADDRESS:

U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423

Emergency telephone #'s: 0700-1630 EST: 410-671-4411/4414
After: 1630 EST: 410- 278-5201, Ask for Staff Duty Officer

CAS REGISTRY NUMBER: 77-81-6

CHEMICAL NAME:

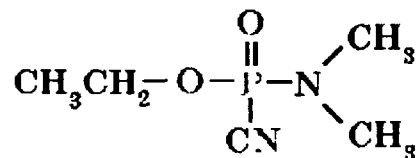
Ethyl N,N-dimethylphosphoramidocyanidate

TRADE NAME AND SYNONYMS:

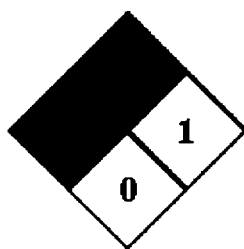
Ethyl dimethylphosphoramidocyanidate
Dimethylaminoethoxy-cyanophosphine oxide
Dimethylamidoethoxyphosphoryl cyanide
Ethyl dimethylaminocyanophosphonate
Ethyl ester of dimethylphosphoroamidocyanidic acid
Ethylphosphorodimethylamidocyanidate
GA
EA1205
Tabun

CHEMICAL FAMILY: Organophosphorus compound

FORMULA/CHEMICAL STRUCTURE:
C5 H11 N2 O2 P



NFPA 704 SIGNAL:



Health - 4
Flammability - 2
Reactivity - 1
Special - 0

SECTION II - HAZARDOUS INGREDIENTS

<u>INGREDIENTS NAME</u>	<u>FORMULA</u>	<u>PERCENTAGE BY WEIGHT</u>	<u>AIRBORNE EXPOSURE LIMIT (AEL)</u>
GA	C5H11N2O2P	100	0.0001 mg/m3

SECTION III - PHYSICAL DATA

BOILING POINT DEG: 220ø C to 246ø C @ 760 mm Hg

VAPOR PRESSURE (mm Hg): 0.037 @ 20 C

VAPOR DENSITY (AIR=1): 5.63

SOLUBILITY: Slightly soluble in water: (g/100 g): 9.8 @ 25 C; 7.2 @ 20 C. Readily soluble in organic solvents.

SPECIFIC GRAVITY (H2O=1): Not available

FREEZING/MELTING POINT: -50 C

LIQUID DENSITY (g/cc): 1.073 @ 25 C

VISCOSITY (CENTISTOKE): 2.18 @ 25 C

VOLATILITY: 610 mg/m3 @ 25 C

APPEARANCE & ODOR: Colorless to brown liquid, faintly fruity odor. No odor when pure.

SECTION IV - FIRE AND EXPLOSION DATA

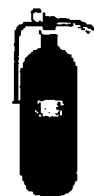
FLASHPOINT: 78 C

FLAMMABILITY LIMITS (% by volume): Not available



EXTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid using extinguishing methods that will cause splashing or spreading of the GA.

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving GA should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing (See Section VIII).



Do not breathe fumes. Skin contact with nerve agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with the agent liquid or vapor can be fatal.

UNUSUAL FIRE & EXPLOSION HAZARDS: Fires involving this chemical may result in the formation of hydrogen cyanide, HCN.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMITS (AEL): The permissible airborne exposure concentration for GA for an 8-hour workday or a 40-hour work week is an 8-hour time weighted average (TWA) of 0.0001 mg/m³. This value is listed in "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX." To date, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for GA.

GA is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

EFFECTS OF OVEREXPOSURE: GA is a lethal cholinesterase inhibitor similar in action to GB. Although only about half as toxic as GB by inhalation, GA in low concentrations is more irritating to the eyes than GB. The number and severity of symptoms that appear are dependent on the quantity and rate of entry of the nerve agent introduced into the body. (Very small skin dosages sometimes cause local sweating and tremors with few other effects.) Individuals poisoned by GA display approximately the same sequence of symptoms despite the route by which the poison enters the body (whether by inhalation, absorption, or ingestion). These symptoms, in normal order of appearance, are: a runny nose; tightness of the chest; dimness of vision and pin pointing of the eye pupils; difficulty in breathing; drooling and excessive sweating; nausea; vomiting, cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsion. These symptoms are followed by cessation of breathing and death.

Onset Time of Symptoms: Symptoms appear much more slowly from a skin dosage than from a respiratory dosage. Although skin absorption great enough to cause death may occur in 1 to 2 minutes, death may be delayed for 1 to 2 hours. Respiratory lethal dosages kill in 1 to 10 minutes, and liquid in the eye kills almost as rapidly.

Median Lethal Dosage, Animals:

LD₅₀ (monkey, percutaneous) = 9.3 mg/kg (shaved skin)

LC₅₀ (monkey, inhalation) = 187 mg-min/m³ (t = 10)

Median Lethal Dosage, Man:

LC₅₀ (man, inhalation) = 135 mg-min/m³ (t = 0.5-2 min) at RMV* of 15 l/min;

(2) Some of the early symptoms of a percutaneous exposure may be local muscular twitching or sweating at the area of exposure followed by nausea or vomiting.

(3) Although myosis (pin-pointing of the pupils) may be an early sign of agent exposure, an injection shall not be administered when myosis is the only sign present. Instead, the individual shall be taken immediately to the medical facility for observation.

(4) Injections using the MARK I kit injectors (or atropine only if directed by the local physician) may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections shall be given unless directed by the physician-in-charge. In addition, a record shall be maintained of all injections given.

(5) Administer, in rapid succession, all three MARK I kit injectors (or atropine if directed by the local physician) in the case of SEVERE signs of agent exposure.

e. If indicated, CPR should be started immediately. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists.

CAUTION: Atropine does not act as a prophylactic and shall not be administered until an agent exposure has been ascertained.

200 mg-min/m³ at RMV* of 10 l/min

*Respiratory Minute Volume

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, loss of coordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.



EYE CONTACT: IMMEDIATELY flush eyes with water for at least 15 minutes then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to a medical treatment facility for observation.

SKIN CONTACT: Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminate. Administer an intramuscular injection with the MARK I kit injectors only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.

INGESTION: Do not induce vomiting. First symptoms are likely to be gastrointestinal. IMMEDIATELY administer Nerve Agent Antidote Kit(s), MARK I injectors. Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable

INCOMPATIBILITY: Not available

HAZARDOUS DECOMPOSITION: Decomposes within six months at 60 C. Complete decomposition in 3-1/4 hours at 150 C. May produce hydrogen cyanide (HCN). Oxides of nitrogen, oxides of phosphorus, carbon monoxide, and HCN.

HAZARDOUS POLYMERIZATION: Not available

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If leaks or spills occur, only personnel in full protective clothing will remain in the area (See Section VIII). In case of personnel contamination see Section V for emergency and first aid instructions.

RECOMMENDED FIELD PROCEDURES: Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. This containment is followed by treatment with copious amounts of aqueous sodium hydroxide solution (a minimum 10 wt.%). Scoop up all material and clothing and place in a DOT approved container. The decontamination solution must be treated with excess bleach to destroy the HCN formed during the hydrolysis. Cover the contents with

additional bleach . After sealing, the exterior of the container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, State, and local laws. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).

If 10 wt.% sodium hydroxide is not available then the following decontaminants may be used instead and are listed in order of preference: Decontaminating Agent, D2 (DS2), Sodium Carbonate and Supertropical Bleach Slurry (STB).

RECOMMENDED LABORATORY PROCEDURES: A minimum of 56 grams of decon solution is required for each gram of GA. The decontamination solution is agitated while GA is added and the agitation is maintained for at least one hour. The resulting solution is allowed to react for 24 hours. At the end of 24 hours, the solution must be titrated to a pH between 10 and 12. After completion of the 24-hour period, the decontamination solution must be treated with excess bleach (2.5 mole OCl/mole GA) to destroy the CN formed during the hydrolysis. Scoop up all material and clothing and place in a DOT container. Cover the contents with additional bleach. After sealing, the exterior of the container will be decontaminated and labeled according to state, EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to State, EPA and DOT regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).

Note: GA may react to form cyanogen chloride (CK) in bleach slurry.

WASTE DISPOSAL METHOD: Open pit burning or burying of GA or items containing or contaminated with GA in any quantity is prohibited. The detoxified GA (using procedures above) can be thermally destroyed by incineration in EPA approved incinerators in accordance with appropriate provisions of Federal, State and local Resource Conservation Recovery Act (RCRA) regulations.



NOTE: Some states define decontaminated surety material as an RCRA hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

CONCENTRATIONRESPIRATORY PROTECTIVE EQUIPMENT< 0.0001 mg/m³

A full face piece, chemical canister, air-purifying protective mask will be on hand for escape. (The M9-, M17-, or M40-series masks are acceptable for this purpose. Other masks certified as equivalent may be used).

>0.0001 or = 0.2 mg/m³

A NIOSH/MSHA approved pressure demand full face piece SCBA or supplied air respirators with escape air cylinder may be used. Alternatively, a full face piece, chemical canister air-purifying protective mask is acceptable for this purpose (See DA PAM 385-61 for determination of appropriate level)

>0.2 mg/m³ or unknown

NIOSH/MSHA approved pressure demand full face piece SCBA suitable for use in high agent concentrations with protective ensemble (See DA PAM 385-61 for examples).

VENTILATION:

Local Exhaust: Mandatory. Must be filtered or scrubbed. Air emissions must meet local, state and federal regulations.

Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke producing devices will be performed in the assessment of the hoods ability to contain agent GA.

Other: Recirculation of exhaust air from agent areas is prohibited. Do not connect agent areas and other areas through the ventilation system. Emergency backup power is necessary. Hoods should be tested at least semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hood face.

PROTECTIVE GLOVES: Butyl Rubber Glove M3 and M4 Norton, Chemical Protective Glove Set

EYE PROTECTION: As a minimum chemical goggles will be worn. For splash hazards use goggles and face shield.

OTHER PROTECTIVE EQUIPMENT: For general lab work, gloves and lab coat will be worn with mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.

MONITORING: Available monitoring equipment for agent GA is the Automatic Chemical Agent Detector Alarm (ACADA), bubblers (GC method), Miniature Chemical Agent Monitor (MINICAM), Chemical Agent Monitor (CAM) and Real Time Analytical Platform (RTAP).

Real-time, low-level monitors (with alarm) are required for GA operations. In their absence, an

Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: In handling agents, the buddy system will be incorporated. No smoking, eating and drinking in areas containing agents is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel



practices must be exercised. Decontamination equipment will be conveniently placed. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap and water before leaving at the end of the workday.

OTHER PRECAUTIONS: Agents must be double contained in liquid and vapor tight containers when in storage or outside a ventilation hood.

For additional information see "AR. 385-61, The Army Toxic Chemical Agent Safety Program," "DA PAM 385-61, Toxic Chemical Agent Safety Standards," and "AR. 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX."

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.

DOT HAZARD CLASSIFICATION: 6.1, Packing Group I, Hazard Zone B

DOT LABEL: Poison

DOT MARKING: Poisonous liquids, n.o.s. (Ethyl dimethylphosphoramidocyanidate)
UN 2810, Inhalation Hazard

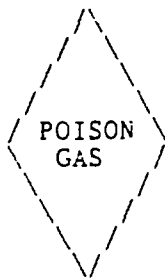
DOT PLACARD: Poison



EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII, and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

While the Edgewood Research Development, and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development, and Engineering Center assume legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.



DATE: 22 January 1991

U.S. ARMY CHEMICAL
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER

Emergency Telephone #s:
CRDEC Safety Division
301-671-4411 0700-1700
EST After normal duty
hours: 301-278-5201
Ask for CRDEC Staff
Duty Officer

GF

MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND
CHEMICAL RESEARCH DEVELOPMENT AND ENGINEERING
CENTER
ATTN: SMCCR-CMS-E
ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: 329-99-7

CHEMICAL NAME: Cyclohexyl methylphosphonofluoridate

Alternate chemical names:

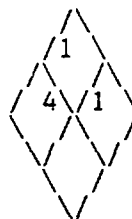
Methylphosphonofluoridic acid, cyclohexyl ester
Methyl cyclohexylfluorophosphonate
Cyclohexyl ester of methylphosphonofluoridic acid
Cyclohexylmethylfluorophosphonate
Methylfluorocyclohexylphosphonate

TRADE NAME AND SYNONYMS: GF

CHEMICAL FAMILY: Fluorinated Organophosphorus Compound

FORMULA/CHEMICAL STRUCTURE: C7 H14 PF (O2)

NFPA 704 SIGNAL: Health - 4
Flammability - 1
Reactivity - 1



SECTION II - COMPOSITION

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
Cyclohexyl methyl- phosphonofluoridate	C7(H14)PF(O2)	100	*

* None established/available

SECTION III - PHYSICAL DATA

BOILING POINT DEG F (DEG C): 71 DEG C at 1.5 torr
80 DEG C at 4.0 torr
105 DEG C at 14.0 torr

239 DEG C at 760.0 torr

VAPOR PRESSURE (torr): 0.0063 at 0 DEG C
0.0700 at 25 DEG C
0.158 at 37 DEG C
2.2 at 71 DEG C

VAPOR DENSITY (AIR=1): 6.2 (calculated)

SOLUBILITY IN WATER: 37 g/1000 g water at 20 DEG C

SPECIFIC GRAVITY (H2O=1): 1.135 at 20 DEG C

FREEZING (MELTING) POINT: Freezes below -30 DEG C, melts at -12 DEG C

AUTOIGNITION TEMPERATURE DEG F (DEG C): Data not available

VISCOSITY (CENTISTOKES): 4.82 at 25 DEG C

VOLATILITY: 67 mg/m3 at 0 DEG C
550 mg/m3 at 25 DEG C
5000 mg/m3 at 52 DEG C

APPEARANCE & ODOR: Clear liquid

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: 94 DEG C (calculated)

FLAMMABILITY LIMITS (% by volume): Data not available

SPECIAL FIRE FIGHTING PROCEDURES: GF will react with steam or water to produce toxic and corrosive vapors. All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving GF should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, fire-fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

EXTINGUISHING MEDIA: Water mist, fog, foam, CO2 - Avoid using extinguishing methods that will cause splashing or spreading of the GF.

UNUSUAL FIRE & EXPLOSION HAZARDS: Hydrogen may be present.

SECTION V - HEALTH HAZARD DATA

NOTE: Where detailed data for GF are not available, Health Hazard and information is taken from the MSDS for Agent GB.

AIRBORNE EXPOSURE LIMIT: The suggested permissible airborne exposure concentration for GF for an 8-hour workday of a 40 hour work week is an 8-hour Time Weighted Average (TWA) of 0.0001 mg/m3. This value is based on the TWA of GB as proposed in the USAEHA Technical Guide No. 169, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX". To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for GF.

GF presently is not listed by the International Agency for Research on Can-

cer (IARC), National Toxicology Program (NTP), Occupational Safety and Health Administration (OSHA), or American Conference of Governmental Industrial Hygienists (ACGIH) as a carcinogen.

EFFECTS OF OVEREXPOSURE: **

Symptoms:

a. One to several minutes after overexposure to airborne GF, the following acute symptoms appear:

(1) Local effects (lasting 1-15 days, increases with dose):

(a) On eyes: Miosis (constriction of pupils); redness, pressure and heaviness in and behind the eyes.

(b) By inhalation: Rhinorrhea (runny nose), nasal congestion, tightness in chest, wheezing, salivation, nausea, vomiting.

(2) Systemic effects (increase with dose): By inhalation - excessive secretion causing coughing/breathing difficulty; salivation and sweating; vomiting, diarrhea; stomach cramps; involuntary urination/defecation; generalized muscle twitching/cramps; CNS depression including anxiety; restlessness, giddiness, insomnia, excessive dreaming and nightmares. With more severe exposure: headache, tremor, drowsiness, concentration difficulty, memory impairment, confusion, unsteadiness on standing or walking.

b. After overexposure to liquid GF, the following acute symptoms appear:

(1) Local Effects:

(a) On eyes; Miosis, redness, pressure sensation on eyes.

(b) By ingestion: Salivation, anorexia, nausea, vomiting, abdominal cramps, diarrhea, involuntary defecation, heartburn.

(c) On skin: Sweating, muscle twitching.

(2) Systemic Effects: Similar to generalized effects from exposure to airborne GB.

c. Chronic overexposure to GF causes forgetfulness, thinking difficulty, vision disturbances, muscular aches/pains. Although certain organophosphate pesticides have been shown to be teratogenic in animals, these effects have not been documented in carefully controlled toxicological evaluations for GF.

** Information is a trade secret/Confidential and can be obtained from the Manufacturer at the address listed above.

**** See Addendum A for detailed information about this section ****

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Hold breath until respiratory protective mask is donned. If symptoms appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer Nerve Agent Antidote Kit(s), MARK I (up to three (3) MARK sets if necessary). If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

EYE CONTACT: Immediately flush eyes with water for 10-15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to the medical treatment facility for observation.

SKIN CONTACT: Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminate. Administer an intramuscular injection with the MARK I kit injectors only if local sweating and muscular twitching symptoms are observed. SEEK MEDICAL ATTENTION IMMEDIATELY.

INGESTION: Do not induce vomiting. First symptoms are likely to be gastrointestinal. Immediately administer an intramuscular injection of the MARK I kit auto-injectors. SEEK MEDICAL ATTENTION IMMEDIATELY.

***** See addendum B for detailed instructions *****

SECTION VI - REACTIVITY DATA

STABILITY: Stable when pure.

INCOMPATIBILITY: Attacks tin, magnesium, cadmium plated steel, some aluminums. slight attack on copper, brass, lead, practically no attack on 1020 steel, Inconel & K-monel.

Hydrolyzes to form HF under acid conditions and cyclohexyl alcohol and polymers under basic conditions.

HAZARDOUS DECOMPOSITION: **

HAZARDOUS POLYMERIZATION: Data not available.

** Information is a trade secret/confidential and can be obtained from the manufacturer at the address listed above.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If leak or spills occur, only personnel in full protective clothing (see section 8) will remain in area. In case of personnel contamination see Section V "Emergency and First Aid Instructions".

Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. This containment is followed by treatment with: (1) 5 to 10 percent aqueous sodium or potassium hydroxide and sufficient alcohol to form a homogeneous solution with a pH greater than or equal to 12 for 1 hour; or (2) DS2 in a ratio of at least twice the weight of DS2 to the weight of GF. Sufficient decontaminant solution should be readily available where GF is being used. Scoop up all material and place in a fully removable head drum with a high density polyethylene liner. Cover the contents of the drum with decontaminating solution, as above, before affixing the drum head. After sealing the head, the exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of material used to decontaminate exterior of drum IAW EPA and DOT regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Section 2 and 8).

WASTE DISPOSAL METHOD: Open pit burning or burying of GF or items containing or contaminated with GF in any quantity is prohibited. GF shall be disposed of as follows:

Detoxify the GF using a minimum 10 percent aqueous sodium or potassium hydroxide solution. A minimum of 56 grams of decon solution is required for each gram of GF. Final pH will be greater than 11.5 for not less than

60 minutes for GF. An alternate method of decontaminating GF uses aqueous sodium carbonate with a 3 hour residence time. DS2 may be used if it is used as received in a ratio of 4000 grams/mole neat GF. Analyze the waste to assure all GF has been destroyed. For thermal destruction, incinerate in an EPA approved incinerator.

NOTE: Some states define decontaminated surety material as a RCRA hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

Concentration mg/m3	Respiratory Protection/Ensemble Required
Less than 0.0001	M9, M17, or M40 series mask shall be available for this purpose.
0.0001 to 0.2 mg/m3	M9, or M40 series mask with Level A or Level B ensemble (see AMCR 385-131 for determination of appropriate level). Demilitarization Protective Ensemble (DPE), or Toxicological Agent Protective Ensemble Self-Contained (TAPES), used with prior approval from AMC Field Safety Activity.
Greater than 0.2 or unknown	DPE or TAPES used with prior approval from AMC Field Safety Activity.

NOTE: When DPE or TAPES is not available the M9 or M40 series mask with Level A protective ensemble can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed one hour.

As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots respectively to reduce aspiration.

VENTILATION: Local exhaust: Mandatory, must be filtered or scrubbed to limit exit concentration to less than 0.0001 mg/m3, averaged over 8 hour/day indefinitely.

Special Ventilation: Chemical laboratory hoods shall have an average inward face velocity of 100 lfpm plus or minus 10 % with the velocity at any point not deviating from the average face velocity by more than 20 %. Laboratory hoods shall be located such that cross drafts do not exceed 20 percent of the inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in the assessment of the hoods ability to contain agent GF. Emergency backup power necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hood face.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system.

PROTECTIVE GLOVES: Butyl Glove M3 and M4
Norton, Chemical Protective Glove Set

EYE PROTECTION: Chemical goggles. When there is potential for severe exposure (e.g., sampling pressurized system, loading and unloading operations) chemical goggles and full face shield are recommended.

OTHER PROTECTIVE EQUIPMENT: Full protective clothing (Level A) will consist of the M3 Butyl rubber suit with hood, M2A1 boots, M3 gloves, coveralls, fatigues, or similar (with drawers and undershirt) and socks, M9 mask or the Demilitarization Protective Ensemble (DPE). For general lab work, gloves and lab coat shall be worn with M9 or M17 mask readily available.

MONITORING: Data not available

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: In handling, the buddy system will be incorporated. No smoking, eating and drinking in areas containing agent is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel practices must be exercised. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities be provided. Each worker will wash their hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap before leaving at the end of the work day.

OTHER PRECAUTIONS: Agents must be double contained in liquid and vapor tight containers when in storage or when outside of ventilation hood.

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquid, n.o.s.

DOT HAZARD CLASSIFICATION: Poison A

DOT LABEL: Poisonous Gas

DOT MARKING: Poisonous liquid, n.o.s. (cyclohexyl methylphosphono-
fluoridate) NA 1955

DOT PLACARD: POISON GAS

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency.

AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See sections IV, VII, and VIII.

While the Chemical Research, Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Chemical Research, Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

1. Acute Physiological Effects:

Site of Action	Signs and Symptoms Following Local Exposure
Muscarine-like-	
Pupils	Miosis, marked, usually maximal (pinpoint), sometimes unequal.
Ciliary body	Frontal headache, eye pain on focusing, slight dimness of vision, occasional nausea and vomiting.
Conjunctivae	Hyperemia.
Nasal mucous membranes	Rhinorrhea, hyperemia.
Bronchial tree	Tightness in chest, sometimes with prolonged wheezing expiration suggestive of broncho-constriction or increased secretion, cough.
Following Systemic Absorption	
Bronchial tree	Tightness in chest, with prolonged wheezing, expiration suggestive broncho-constriction or increased secretion, dyspnea, slight pain in chest, increase bronchial secretion, cough, pulmonary edema, cyanosis.
Gastrointestinal	Anorexia, nausea, vomiting, abdominal cramps, epigastric and substernal tightness (cardiospasm) with "heart-burn" and eructation, diarrhea, tenesmus, involuntary defecation.
Sweat glands	Increased sweating.
Salivary glands	Increased salivation.
Lacrimal glands	Increased lacrimation.
Heart	Slight bradycardia.
Pupils	Slight miosis, occasionally unequal, later maximal miosis (pinpoint).
Ciliary body	Blurring of vision.
Bladder	Frequency, involuntary micturition
Nicotine-like-	
Striated muscle	Easy fatigue, mild weakness, muscular twitching, fasciculations, cramps, generalized weakness, including muscles of respiration, with dyspnea and cyanosis.
Sympathetic ganglia	Pallor, occasional elevation of blood pressure.
Central nervous system	Giddiness, tension, anxiety, jitteriness, restlessness, emotional lability, excessive dreaming, insomnia, nightmares, headaches,

tremor, withdrawal and depression, bursts of slow waves of elevated voltage in EEG, especially on over-ventilation, drowsiness, difficult concentration, slowness on recall, confusion, slurred speech, ataxia, generalized weakness, coma, with absence of reflexes, Cheyne-Stokes respirations, convulsions, depression of respiratory and circulatory centers, with dyspnea cyanosis, and fall in blood pressure.

2. Chronic Physiological Effects:

a. Acute Exposure.

If recovery from nerve agent poisoning occurs, it will be complete unless anoxia or convulsions have gone unchecked so long that irreversible central nervous system changes due to anoxemia have occurred.

b. Chronic Exposure.

The inhibition of cholinesterase enzymes throughout the body by nerve agents is more or less irreversible so that their effects are prolonged. Until the tissue cholinesterase enzymes are restored to normal activity, probably by very slow regeneration over a period of weeks or 2 to 3 months if damage is severe, there is a period of increased susceptibility to the effects of another exposure to any nerve agent. During this period the effects of repeated exposures are cumulative; after a single exposure, daily exposure to concentrations of a nerve agent insufficient to produce symptoms may result in the onset of symptoms after several days. Continued daily exposure may be followed by increasingly severe effects. After symptoms subside, increased susceptibility persists for one to several days. The degree of exposure required to produce recurrence of symptoms, and the severity of these symptoms, depend on duration of exposure and time intervals between exposures. Increased susceptibility is not limited to the particular nerve agent initially absorbed.

Estimates have been made for the times at which 50% of exposed subjects would be affected (Et50's) at median incapacitating doses. These are presented below.

Et50	Degree of Effectiveness	ICt50	Exposure Time
min		mg min/m3	min
1.5	Moderate	27	0.5
3.0	Incap.	27	2.0
6.0		40	10.0
1.0	Severe	37	0.5
3.8	Incap.	37	2.0
7.8		56	10.0
2.0	Very	47	0.5
4.5	Severe	47	2.0
9.5	Incap.	72	10.0
6.5	Death	70	0.5
9.0		70	2.0
13.5		103	10.0

Exposure to high concentrations of nerve agent may bring on incoordination, mental confusion and collapse so rapidly that the casualty cannot perform self-aid. If this happens, the man nearest to him will give first aid.

Onset Time of Symptoms.

Types of Effects	Route of Absorption	Description of Effects	When Effects Appear After Exposure
Vapor Local	Lungs	Rhinorrhea, nasal hyperemia tightness in chest, wheezing	One to several minutes
Vapor Local	Eyes	Miosis, Conjunctival hyperemia eye pain, frontal headache.	One to several minutes
Vapor Systemic	Lungs or eyes	Muscarine-like, nicotine-like and central nervous system effects. (See 2a above)	Less than 1 min to a few min after moderate or marked exposure; about 30 min after mild exposure.
Liquid Local	Eyes	Same as vapor effects.	Instantly
Liquid Local	Ingestion	Gastrointestinal. (See 2a above).	About 30 min. after ingestion.
Liquid Local	Skin	Local sweating and muscular twitching.	3 min to 2 hours
Liquid Systemic	Lungs	See 2a above.	Several minutes
Liquid Systemic	Eyes	Same as for vapor	Several minutes
Liquid Systemic	Skin	Generalized sweating.	15 minutes to 2 hours
Liquid Systemic	Ingestion	Gastrointestinal (See 2a above).	15 minutes to 2 hours

Onset Time of Symptoms. (cont'd)

Types of Effects	Route of Absorption	Duration of Effects After	
		Mild Exposure	Severe Exposure
Vapor Local	Lungs	A few hours	1 to 2 days
Vapor Local	Eyes	Miosis - 24 hours	3 to 14 days 2 to 5 days
Vapor Systemic	Lungs or eyes	Several hours	8 days
Liquid Local	Eyes	Similar to effects of vapor	

Liquid Local	Ingestion	3 days	5 days
Liquid Local	Skin	3 days	5 days
Liquid Systemic	Lungs		1 to 5 days
Liquid Systemic	Eyes		2 to 4 days
Liquid Systemic	Skin		2 to 5 days
Liquid Systemic	Ingestion		3 to 5 days

ADDENDUM B

First aid procedures.

a. Exposed personnel will be removed immediately to an uncontaminated atmosphere. Personnel handling casualty cases will give consideration to their own safety and will take precautions and employ the prerequisite protective equipment to avoid becoming exposed themselves.

CAUTION: Due to the rapid effects of nerve agents, it is extremely important that decontamination of personnel not be delayed by attempting to blot off excessive agent prior to decontamination with sodium hypochlorite.

b. The casualty will then be decontaminated by washing the contaminated areas with commercial liquid household bleach (nominal 5% solution hypochlorite or 10 percent sodium carbonate solution) and flushing with clean water to remove excess bleach followed by copious soap and water wash. Mask will be left on the victim until decontamination has been completed unless it has been determined that areas of the face were contaminated and the mask must be removed to facilitate decontamination. After decontamination, the contaminated clothing will be removed and skin contamination washed away. If possible, decontamination will be completed before the casualty is taken to the aid station or medical facility.

CAUTION: Care must be taken when decontaminating facial areas to avoid getting the hypochlorite into the eye or mouth. Only clean water shall be used when flushing the eyes or mouth. Skin surfaces decontaminated with bleach should be thoroughly flushed with water to prevent skin irritation from the bleach.

c. If there is no apparent breathing, artificial resuscitation will be started immediately (mouth-to-mouth; or with mechanical resuscitator). The situation will dictate method of choice, e.g., contaminated face. Do not use mouth-to-mouth resuscitation when facial contamination exists. When appropriate and when trained personnel are available, cardiopulmonary resuscitation (CPR) may be necessary.

d. An individual who has received a known agent exposure or who exhibits definite signs or symptoms of agent exposure shall be given an intramuscular injection immediately with the MARK I kit auto-injectors.

(1) Some of the early symptoms of a vapor exposure may be rhinorrhea (runny nose) and/or tightness in the chest with shortness of breath (bronchial constriction).



MATERIAL SAFETY DATA SHEET

LETHAL NERVE AGENT (VX)



SECTION I - GENERAL INFORMATION

DATE: 14 September 1988
REVISED: 28 February 1996

MANUFACTURER'S ADDRESS:

U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423

Emergency telephone #'s: 0700-1630 EST: 410-671-4411/4414
After: 1630 EST: 410-278-5201, Ask for Staff Duty Officer

CAS REGISTRY NUMBERS: 50782-69-9, 51848-47-6, 53800-40-1, 70938-84-0

CHEMICAL NAME:

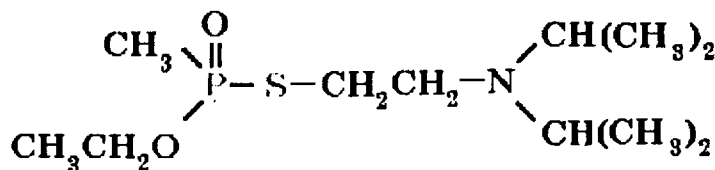
O-ethyl-S-(2-isopropylaminoethyl) methyl phosphonothiolate

TRADE NAME AND SYNONYMS:

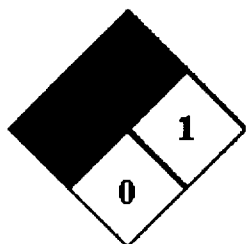
Phosphonothioic acid, methyl-, S-(2-bis(1-methylethylamino)ethyl) 0-ethyl ester
O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothiolate
S-2-Diisopropylaminoethyl O-ethyl methylphosphonothioate
S-2((2-Diisopropylamino)ethyl) O-ethyl methylphosphonothiolate
O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothioate
O-ethyl S-(2-diisopropylaminoethyl) methylthiolphosphonoate
S-(2-diisopropylaminoethyl) o-ethyl methyl phosphonothiolate
Ethyl-S-dimethylaminoethyl methylphosphonothiolate
VX
EA 1701
TX60

CHEMICAL FAMILY: Sulfonated organophosphorous compound

FORMULA/CHEMICAL STRUCTURE:
C₁₁H₂₆NO₂PS



NFPA 704 HAZARD SIGNAL:



Health - 4
Flammability - 1
Reactivity - 1
Special - 0

SECTION II - HAZARDOUS INGREDIENTS

<u>INGREDIENTS EXPOSURE</u>	<u>FORMULA</u>	<u>PERCENTAGE BY WEIGHT</u>	<u>AIRBORNE EXPOSURE LIMIT (AEL)</u>
VX	C11H26NO2PS	100%	0.00001 mg/m3

SECTION III - PHYSICAL DATA

BOILING POINT : 298 C (568 F)

VAPOR PRESSURE (mm Hg): 0.0007 @ 20 C

VAPOR DENSITY (AIR=1): 9.2

FREEZING/MELTING POINT : Below -51 C

LIQUID DENSITY (g/cc): 1.0083 @ 20 C

PERCENTAGE VOLATILE BY VOLUME: 10.5 mg/m3 @ 25 C

SOLUBILITY: Slightly soluble in water at room temperature. Soluble in organic solvents.

APPEARANCE AND ODOR: Colorless to straw colored liquid & odorless, similar in appearance to motor oil.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: 159 C (McCutchan - Young)



FLAMMABILITY LIMITS (% by volume): Not Available

LOWER EXPLOSIVE LIMIT: Not Applicable

UPPER EXPLOSIVE LIMIT: Not Applicable

EXTINGUISHING MEDIA: Water mist, fog, foam, CO2. Avoid using extinguishing methods that will cause splashing or spreading of the VX.

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving VX should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing VX, fire fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief of chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing (See Section VIII).



Do not breathe fumes. Skin contact with nerve agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with liquid VX or vapors can be fatal.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None known.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMITS (AEL): The permissible airborne exposure concentration for VX for an 8-hour workday of a 40-hour work week is an 8-hour time weighted average (TWA) of 0.00001 mg/m³. This value can be found in "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX." To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for VX.

VX is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

EFFECTS OF OVEREXPOSURE: VX is a lethal cholinesterase inhibitor. Doses which are potentially life-threatening may be only slightly larger than those producing least effects. Death usually occurs within 15 minutes after absorption of a fatal dosage.

VX

<u>Route</u>	<u>Form</u>	<u>Effect</u>	<u>Type</u>	<u>Dosage</u>
ocular	vapor	miosis	ECt50	< 0.09 mg-min/m ³
inhalation	vapor	runny nose	ECt50	< 0.09 mg-min/m ³
inhalation (15 l/min)	vapor	severe incapacitation	ICt50	25 mg-min/m ³
inhalation (15 l/min)	vapor	death	LCt50	30 mg-min/m ³
percutaneous	liquid	death	LD50	10 mg/70 kg man

Effective dosages for vapor are estimated for exposure durations of 2-10 minutes.

Symptoms of overexposure may occur within minutes or hours, depending upon the dose. They include: miosis (constriction of pupils) and visual effects, headaches and pressure sensation, runny nose and nasal congestion, salivation, tightness in the chest, nausea, vomiting, giddiness, anxiety, difficulty in thinking, difficulty sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps, diarrhea, involuntary urination and defecation. With severe exposure symptoms progress to convulsions and

respiratory failure.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention **IMMEDIATELY**.



EYE CONTACT: **IMMEDIATELY** flush eyes with water for 10-15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken **IMMEDIATELY** to a medical treatment facility for observation.

SKIN CONTACT: Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove excess decontaminant. Administer nerve agent antidote kit, Mark I, only if local sweating and muscular twitching symptoms are observed. Seek medical attention **IMMEDIATELY**.

INGESTION: Do not induce vomiting. First symptoms are likely to be gastrointestinal. **IMMEDIATELY** administer Nerve Agent Antidote Kit, Mark I. Seek medical attention **IMMEDIATELY**.

SECTION VI - REACTIVITY DATA

STABILITY: Relatively stable at room temperature. Unstabilized VX of 95% purity decomposes at a rate of 5% a month at 71 C.

INCOMPATIBILITY: Negligible on brass, steel, aluminum.

HAZARDOUS DECOMPOSITION PRODUCTS: During a basic hydrolysis of VX up to 10% of the agent is converted to diisopropylaminoethyl methylphosphonothioic acid (EA2192). Based on the concentration of EA2192 expected to be formed during hydrolysis and its toxicity (1.4 mg/kg dermal in rabbit at 24 hours in a 10/90 wt.% ethanol/water solution), a Class B poison would result. The large scale decon procedure, which uses both HTH and NaOH, destroys VX by oxidation and hydrolysis. Typically the large scale product contains 0.2 - 0.4 wt.% EA2192 at 24 hours. At pH 12, the EA2192 in the large scale product has a half-life of about 14 days. Thus, the 90-day holding period at pH 12 results in about a 64-fold reduction of EA2192 (six half-lives). This holding period is sufficient to reduce the toxicity of the product below that of a Class B poison. Other less toxic products are ethyl methylphosphonic acid, methylphosphinic acid, diisopropylaminoethyl mercaptan, diethyl methylphosphonate, and ethanol. The small scale decontamination procedure uses sufficient HTH to oxidize all VX thus no EA2192 is formed.

HAZARDOUS POLYMERIZATION: Does not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If leaks or spills occur,

only personnel in full protective clothing (**See Section VIII**) will remain in area. In case of personnel contamination see (**Section V**) for emergency and first aid instructions.

RECOMMENDED FIELD PROCEDURES (For Quantities greater than 50 grams): (NOTE: These procedures can only be used with the approval of the Risk Manager or qualified safety personnel). Spills must be contained by covering with vermiculite, diatomaceous earth, clay or fine sand. An alcoholic HTH mixture is prepared by adding 100 milliliters of denatured ethanol to a 900-milliliter slurry of 10% HTH in water. This mixture should be made just before use since the HTH can react with the ethanol. Fourteen grams of alcoholic HTH solution are used for each gram of VX. Agitate the decontamination mixture as the VX is added. Continue the agitation for a minimum of one hour. This reaction is reasonably exothermic and evolves substantial off gassing. The evolved reaction gases should be routed through a decontaminate filled scrubber before release through filtration systems. After completion of the one hour minimum agitation, 10% sodium hydroxide is added in a quantity equal to that necessary to assure that a pH of 12.5 is maintained for a period not less than 24 hours. Hold the material at a pH between 10 and 12 for a period not less than 90 days to ensure that a hazardous intermediate material is not formed (**See Section VI**). Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, State, and local regulations. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (**See Sections II and VIII**).

If the alcoholic HTH mixture is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Agent D2 (DS2), Supertropical Bleach Slurry (STB), and Sodium Hypochlorite.

RECOMMENDED LABORATORY PROCEDURES (For Quantities less than 50 grams): If the active chlorine of the Calcium Hypochlorite (HTH) is at least 55%, then 80 grams of a 10% slurry are required for each gram of VX. Proportionally more HTH is required if the chlorine activity of the HTH is lower than 55%. The mixture is agitated as the VX is added and the agitation is maintained for a minimum of one hour. If phasing of the VX/decon solution continues after 5 minutes, an amount of denatured ethanol equal to a 10 wt.% of the total agent/decon will be added to help miscibility. Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, State, and local regulations. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (**See Sections II and VIII**).

NOTE: ETHANOL SHOULD BE REDUCED TO PREVENT THE FORMATION OF A HAZARDOUS WASTE. Upon completion of the one hour agitation the decon mixture will be adjusted to a pH between 10 and 11. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (**See Sections II and VIII**).

WASTE DISPOSAL METHOD: Open pit burning or burying of VX or items containing or contaminated with VX in any quantity is prohibited. The detoxified VX (using procedures above) can be thermally destroyed by in a EPA approved incinerator in accordance with appropriate provisions of Federal, State and local Resource Conservation and Recovery Act (RCRA) regulations.



NOTE: Some states define decontaminated surety material as a RCRA Hazardous Waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:CONCENTRATIONRESPIRATORY PROTECTIVE EQUIPMENT

< 0.00001 mg/m ³	A full face piece, chemical canister, air-purifying protective mask will be on hand for escape. (The M9-, M17-, or M40-series masks are acceptable for this purpose. Other masks certified as equivalent may be used).
>0.00001 or = 0.02 mg/m ³	A NIOSH/MSHA approved pressure demand full face piece SCBA or supplied air respirators with escape air cylinder may be used. Alternatively, a full face piece, chemical canister air-purifying protective mask is acceptable for this purpose (See DA PAM 385-61 for determination of appropriate level)
>0.02 mg/m ³ or unknown	NIOSH/MSHA approved pressure demand full face piece SCBA suitable for use in high agent concentrations with protective ensemble (See DA PAM 385-61 for examples).

VENTILATION:

Local exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentration to < 0.00001 mg/m³. Air emissions will meet local, state and federal regulations.

Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (lfpm) +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross-drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke-producing devices will be performed in assessing the ability of the hood to contain agent VX.

Other: Recirculation or exhaust air from chemical areas is prohibited. No connection between chemical areas and other areas through ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested at least semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hood face.

PROTECTIVE GLOVES: Butyl Rubber Glove M3 and M4 Norton, Chemical Protective Glove Set

EYE PROTECTION: At a minimum chemical goggles will be worn. For splash hazards use goggles and face shield.

OTHER PROTECTIVE EQUIPMENT: For laboratory operations, wear lab coats, gloves and have mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.

MONITORING: Available monitoring equipment for agent VX is the M8/M9 detector paper, detector ticket, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAMMS), Automated Continuous Air Monitoring System (ACAMS), Real-Time Monitor (RTM), Demilitarization Chemical

Agent Concentrator (DCAC), M8/M43, M8A1/M43A1, CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), the Miniature Chemical Agent Monitor (MINICAM), and the Real Time Analytical Platform (RTAP).

Real-time, low-level monitors (with alarm) are required for VX operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When handling agents the buddy system will be incorporated. No smoking, eating, and drinking in areas containing chemicals is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel



practices must be exercised. Decontamination equipment will be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations and personal cleanliness facilities must be provided. Wash hands before meals, each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap and water before leaving at the end of the workday.

OTHER PRECAUTIONS: VX must be double contained in liquid and vapor tight containers when in storage or outside a ventilation hood.

For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety Program," "DA PAM 385-61, Toxic Chemical Agent Safety Standards," and "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX."

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.

DOT HAZARD CLASS: 6.1 Packing Group I, Zone A

DOT LABEL: Poison

DOT MARKING: Poisonous liquids, n.o.s. (O-ethyl S-(2-diisopropylaminoethyl)methyl phosphonothiolate) UN 2810, Inhalation Hazard

DOT PLACARD: Poison



EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded, regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

While the Edgewood Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development, and Engineering Center assume legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of

these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.



MATERIAL SAFETY DATA SHEET

DISTILLED MUSTARD (HD)



SECTION I - GENERAL INFORMATION

DATE: 22 September 1988
REVISED: 28 February 1996

MANUFACTURER'S ADDRESS:

U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423

Emergency telephone #'s: 0700-1630 EST: 410-671-4411/4414
After: 1630 EST: 410- 278-5201, Ask for Staff Duty Officer

CAS REGISTRY NUMBERS: 505-60-2, 39472-40-7, 68157-62-0

CHEMICAL NAME:

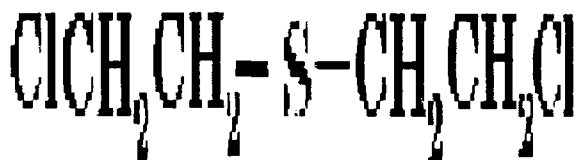
Bis-(2-chloroethyl)sulfide

TRADE NAMES AND SYNONYMS:

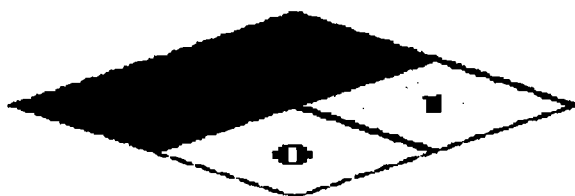
Sulfide, bis (2-chloroethyl)
Bis(beta-chloroethyl)sulfide
1,1'-thiobis(2-chloroethane)
1-chloro-2(beta-chloroethylthio)ethane
Beta, beta'-dichlorodiethyl sulfide
2,2'dichlorodiethyl sulfide
Di-2-chloroethyl sulfide
Beta, beta'-dichloroethyl sulfide
2,2'-dichloroethyl sulfide
H; HD; HS
Iprit
Kampstoff "Lost"; Lost
Mustard Gas
S-Lost; S-yperite; Schewefel-lost
Senfgas
Sulfur mustard; Sulphur mustard gas
Yellow Cross Liquid

Yperite
Y

CHEMICAL FAMILY: Chlorinated sulfur compound

FORMULA/CHEMICAL STRUCTURE:
C₄H₈Cl₂S

NFPA 704 HAZARD SIGNAL:

Health - 4
Flammability - 1
Reactivity - 1
Special - 0

SECTION II - HAZARDOUS INGREDIENTS

<u>INGREDIENTS NAME</u>	<u>FORMULA</u>	<u>PERCENTAGE BY WEIGHT</u>	<u>AIRBORNE EXPOSURE LIMIT (AEL)</u>
Sulfur Mustard	C ₄ H ₈ Cl ₂ S	100	0.003 mg/m ³

SECTION III - PHYSICAL DATA

BOILING POINT: 422 F 217 C

VAPOR PRESSURE (mm Hg):

0.072 mm Hg @ 20 C

0.11 mm Hg @ 25 C

VAPOR DENSITY (AIR=1): 5.5

SOLUBILITY IN WATER: Negligible. Soluble in fats and oils, gasoline, kerosene, acetone, carbon tetrachloride, alcohol, tetrachloroethane, ethylbenzoate, and ether. Miscible with the organophosphorus nerve agents.

SPECIFIC GRAVITY (H₂O=1): 1.27 @ 20 C

FREEZING POINT: 14.45 C

LIQUID DENSITY (g/cc):

1.268 @ 25 C

1.27 @ 20 C

PERCENTAGE VOLATILE BY VOLUME:

610 mg/m³ @ 20 C

920 mg/m³ @ 25 C

APPEARANCE AND ODOR: Normally amber to black colored liquid with garlic or a horseradish odor. Water clear if pure. The odor threshold for HD is 0.6 mg/m³ (.0006 mg/L).

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT
: 105 C (Can
be ignited by
large
explosive
charges)



FLAMMABILITY LIMITS (% by volume): Unknown

EXTINGUISHING MEDIA: Water, fog, foam, CO₂. Avoid use of extinguishing methods that will cause splashing or spreading of HD.

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving HD should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing (See Section VIII).



Do not breathe fumes. Skin contact with agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with the agent liquid or vapor can be fatal.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMIT (AEL): The AEL for HD is 0.003 mg/m³ as found in "AR 40-173, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, HT." To date, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for HD.

EFFECTS OF OVEREXPOSURE: HD is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. The rate of detoxification of HD in the body is very slow and repeated exposures produce a cumulative effect. HD has been found to be a human carcinogen by the International Agency for Research on Cancer (IARC).

Median doses of HD in man are:

LD₅₀ (skin) = 100 mg/kg IC_{t50} (skin) = 2000 mg-min/m³ at 70 - 80 F (humid environment)
= 1000 mg-min/m³ at 90 F (dry environment)

IC_{t50} (eyes) = 200 mg-min/m³

IC_{t50} (inhalation) = 1500 mg-min/m³ (C_t unchanged with time)

LD₅₀ (oral) = 0.7 mg/kg

Maximum safe C_t for skin and eyes are 5 and 2 mg-min/m³, respectively.

ACUTE PHYSIOLOGICAL ACTION OF HD IS CLASSIFIED AS LOCAL AND SYSTEMIC.

LOCAL ACTIONS: HD effects both the eyes and the skin. SKIN damage occurs after percutaneous absorption. Being lipid soluble, HD can be absorbed into all organs. Skin penetration is rapid without skin irritation. Swelling (blisters) and reddening (erythema) of the skin occurs after a latency period of 4-24 hours following the exposure, depending on degree of exposure and individual sensitivity. The skin healing process is very slow. Tender skin, mucous membrane and perspiration-covered skin are more sensitive to the effects of HD. HD's effect on the skin, however, is less than on the eyes. Local action on the eyes produces severe necrotic damage and loss of eyesight. Exposure of eyes to HD vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea.

SYSTEMIC ACTIONS: Occurs primarily through inhalation and ingestion. The HD vapor or aerosol is less toxic to the skin or eyes than the liquid form. When inhaled, the upper respiratory tract (nose, throat, tracheae) is inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, loss of appetite, diarrhea, fever, and apathy. Exposure to nearly lethal doses of HD can produce injury to bone marrow, lymph nodes, and spleen as showed by a drop in white blood cell count, thus resulting in increased susceptibility to local and systemic infections. Ingestion of HD will produce severe stomach pains, vomiting, and bloody stools after a 15-20 minute latency period.

CHRONIC EXPOSURE : HD can cause sensitization, chronic lung impairment, (cough, shortness of breath, chest pain), cancer of the mouth, throat, respiratory tract and skin, and leukemia. It may also cause birth defects.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Hold breath until respiratory protective mask is donned. Remove from the source

IMMEDIATELY. If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth

resuscitation when facial contamination exists. Seek medical attention IMMEDIATELY.



EYE CONTACT: Speed in decontaminating the eyes is absolutely essential. Remove the person from

the liquid source, flush the eyes immediately with water for at least 15 minutes by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the patient to a medical facility **IMMEDIATELY**.

SKIN CONTACT: Don respiratory protective mask. Remove the victim from agent sources immediately. Immediately wash skin and clothes with 5% solution of sodium hypochlorite or liquid household bleach within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5% sodium hypochlorite solution, then wash contaminated skin area with soap and water. Seek medical attention **IMMEDIATELY**.

INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention **IMMEDIATELY**.

SECTION VI - REACTIVITY DATA

STABILITY: Stable at ambient temperatures. Decomposition temperature is 149 C to 177 C. Mustard is a persistent agent depending on pH and moisture, and has been known to remain active for up to three years in soil.

INCOMPATIBILITY: Rapidly corrosive to brass @ 65 C. Will corrode steel at a rate of .0001 in. of steel per month @ 65 C.

HAZARDOUS DECOMPOSITION: Mustard will hydrolyze to form HCl and thiodiglycol.

HAZARDOUS POLYMERIZATION: Does not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If spills or leaks occur, only personnel in full protective clothing will remain in the area (**See Section VIII**). In case of personnel contamination **See Section V** for emergency and first aid instructions.

RECOMMENDED FIELD PROCEDURES: The HD should be contained using vermiculite, diatomaceous earth, clay or fine sand and neutralized as soon as possible using copious amounts of 5.25% sodium hypochlorite solution. Scoop up all material and clothing and place in a approved DOT container. Cover the contents of the container with decontaminating solution as above. The exterior of the container will be decontaminated and labeled according with EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with EPA and DOT regulations. Dispose of the material in accordance with waste disposal methods provided below. Dispose of the decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (**See Sections II and VIII**).

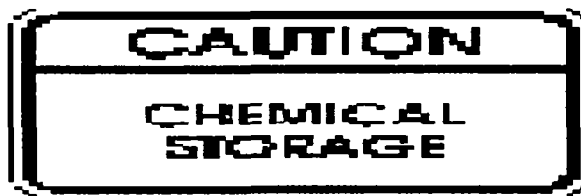
If 5.25 % sodium hypochlorite solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Calcium Hypochlorite, contamination Solution No. 2 (DS2), and Super Tropical Bleach Slurry (STB).

WARNING: Pure, undiluted calcium hypochlorite will burn on contact with liquid HD.

RECOMMENDED LABORATORY PROCEDURES: A minimum of 65 grams of decon solution per gram of HD is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 hours, the resulting solution will be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Place 3 ml of the decontaminate in a test tube. Add several crystals of potassium iodine and swirl to dissolve. Add 3 ml of 50 wt.% sulfuric acid:water and swirl. IMMEDIATE iodine color shows the presence of active chlorine. If negative, add additional 5.25% sodium hypochlorite solution to the decontamination solution, wait two hours, then test again for active chlorine. Continue procedure until positive chlorine is given by solution. A 10 wt.% calcium hypochlorite (HTH) mixture may be substituted for sodium hypochlorite. Use 65 grams of decon per gram of HD and continue the test as described for sodium hypochlorite. Scoop up all material and clothing and place in a approved DOT container. Cover the contents of the container with decontaminating solution as above. The exterior of the container will be decontaminated and labeled according with EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with EPA and DOT regulations. Dispose of the material in accordance with waste disposal methods provided below. Dispose of the decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Section VIII).

NOTE: Surfaces contaminated with HD, then rinse and decontaminated may evolve sufficient HD vapor to produce a physiological response. HD on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid.

WASTE DISPOSAL METHOD: Open pit burning or burying of HD or items containing or



contaminated with HD in any quantity is prohibited. Decontamination of waste or excess material will be accomplished according to the procedures outlined above can be destroyed by incineration in EPA approved incinerators according to appropriate provisions of Federal, State and local Resource Conservation Recovery Act (RCRA) regulations.

NOTE: Some states define decontaminated surety material as a RCRA hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

CONCENTRATION RESPIRATORY PROTECTIVE EQUIPMENT.

< 0.003 mg/m ³	A full face piece, chemical canister, air purifying protective mask will be on hand for escape. (The M9-, M17-, or M40-series masks are acceptable for this purpose. Other masks certified as equivalent may be used)
0.003 mg/m ³	A NIOSH/MSHA approved pressure demand full face piece SCBA suitable for use in high agent concentrations with protective ensemble. (See DA PAM 385-61 for examples).

VENTILATION:

Local Exhaust: Mandatory. Must be filtered or scrubbed. Air emissions will meet local, state and federal regulations.

Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (lfpm) +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke producing devices will be performed in assessing the ability of the hood to contain agent HD.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system are permitted. Emergency backup power is necessary. Hoods should be tested semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hoods.

PROTECTIVE GLOVES: Butyl Rubber Gloves M3 and M4 Norton, Chemical Protective Glove Set

EYE PROTECTION: As a minimum, chemical goggles will be worn. For splash hazards use goggles and face shield.

OTHER PROTECTIVE EQUIPMENT: For laboratory operations, wear lab coats, gloves and have mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.

MONITORING: Available monitoring equipment for agent HD is the M8/M9 detector paper, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAMMS), Automated Continuous Air Monitoring System (ACAMS), CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), the Miniature Chemical Agent Monitor (MINICAM), and Real Time Analytical Platform (RTAP).

Real-time, low-level monitors (with alarm) are required for HD operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When handling agents, the buddy system will be incorporated. No smoking, eating, or drinking in areas containing agents is permitted. Containers should be periodically inspected for leaks, (either visually or using a

**EMERGENCY
SHOWER**



**EYE WASH
FOUNTAIN**



detector kit). Stringent control over all personnel practices must be exercised. Decontaminating equipment will be conveniently placed. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap and water before leaving at the end of the work day .

OTHER PRECAUTIONS: HD should be stored in containers made of glass for Research, Development, Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent will be double-contained in liquid and vapor tight containers when in storage.

For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety Program," "DA PAM 385-61, Toxic Chemical Agent Safety Standards," and "AR 40-173, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to HD Agents H, HD, and HT."

SECTION X - TRANSPORTATION DATA

FORBIDDEN FOR TRANSPORT OTHER THAN VIA MILITARY (TECHNICAL ESCORT UNIT) TRANSPORT ACCORDING TO 49 CFR 172

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.

DOT HAZARD CLASS: 6.1, Packing Group I, Hazard Zone B

DOT LABEL: Poison

DOT MARKING: Poisonous liquids, n.o.s. Bis-(2-chloroethyl) sulfide UN 2810, Inhalation Hazard

DOT PLACARD: POISON 

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Drivers shall be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted in accordance with AR 740-32.

While the Edgewood Research Development, and Engineering Center, Department of the Army believes that the data contained herein are actual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development, and Engineering Center assume legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

ADDENDUM A ADDITIONAL INFORMATION FOR THICKENED HD

TRADE NAME AND SYNONYMS: Thickened HD, THD

HAZARDOUS INGREDIENTS: K125 (acryloid copolymer, 5%) is used to thicken HD. K125 is not known to be hazardous except in a finely-divided, powder form.

PHYSICAL DATA: Essentially the same as HD except for viscosity. The viscosity of HD is between 1000 and 1200 centistoke @ 25 C.

FIRE AND EXPLOSION DATA: Same as HD.

HEALTH HAZARD DATA: Same as HD except for skin contact. For skin contact, don respiratory protective mask and remove contaminated clothing IMMEDIATELY. IMMEDIATELY scrape the HD from the skin surface, then wash the contaminated surface with acetone. Seek medical attention IMMEDIATELY.

SPILL, LEAK, AND DISPOSAL PROCEDURES: If spills or leaks of HD occur, follow the same procedures as those for HD, but dissolve THD in acetone before introducing any decontaminating solution. Containment of THD is generally not necessary. Spilled THD can be carefully scraped off the contaminated surface and placed in a fully removable head drum with a high density, polyethylene lining. THD can then be decontaminated, after it has been dissolved in acetone, using the same procedures used for HD. Contaminated surfaces should be treated with acetone, then decontaminated using the same procedures as those used for HD.

NOTE: Surfaces contaminated with THD or HD and then rinse-decontaminated may evolve sufficient HD vapor to produce a physiological response.

SPECIAL PROTECTION INFORMATION: Same as HD.

SPECIAL PRECAUTIONS: Same as HD with the following addition. Handling THD requires careful observation of the "stringers" (elastic, threadlike attachments) formed when the agents are transferred or dispensed. These stringers must be broken cleanly before moving the contaminating device or dispensing device to another location, or unwanted contamination of a working surface will result.

TRANSPORTATION DATA: Same as HD.

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MATERIAL SAFETY DATA SHEET

LEWISITE



SECTION I - GENERAL INFORMATION

DATE: 16 April 1988

REVISED: 27 March 1996

MANUFACTURER'S ADDRESS:

U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND EDGEWOOD RESEARCH
DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423

Emergency telephone #'s: 0700-1630 EST: 410-671-4411/4

After: 1630 EST: 410- 278-5201, Ask for Staff Duty Officer

CAS REGISTRY NUMBER: 541-25-3

CHEMICAL NAME:

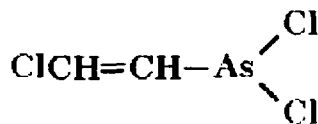
Dichloro-(2-chlorovinyl) arsine

TRADE NAME AND SYNONYMS:

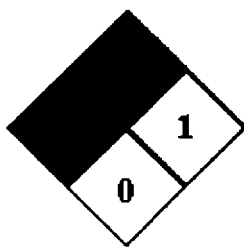
Arsine, (2-chlorovinyl) dichloro-
Arsonous dichloride, (2-chloroethenyl)
Chlorovinylarsine dichloride
2-Chlorovinyl dichloroarsine
Beta-Chlorovinyl dichloroarsine
Lewisite
L
EA 1034

CHEMICAL FAMILY: Arsenical (vesicant)

FORMULA/CHEMICAL STRUCTURE: C₂H₂AsCl₃



NFPA 704 HAZARD SIGNAL:



Health - 4
Flammability - 1
Reactivity - 1
Special - 0

SECTION II - HAZARDOUS INGREDIENTS

<u>INGREDIENTS NAME</u>	<u>FORMULA</u>	<u>PERCENTAGE BY WEIGHT</u>	<u>AIRBORNE EXPOSURE LIMIT (AEL)</u>
Lewisite	C ₂ H ₂ AsCl ₃	100	* 0.003 mg/m ³

* This is a ceiling value

SECTION III - PHYSICAL DATA

BOILING POINT: 374 F 190 C

VAPOR PRESSURE (mm Hg):

0.35 @ 25 C
0.394 @ 20 C

VAPOR DENSITY (AIR=1): 7.1

SOLUBILITY: Insoluble in water and dilute mineral acids. Soluble in organic solvents, oils. and alcohol.

SPECIFIC GRAVITY (H₂O=1): 1.88 @ 25 C

FREEZING POINT: 18 C to 0.1 C depending on purity

VOLATILITY: 4,480 mg/m³ @ 20 C

MOLECULAR WEIGHT: 207.32

LIQUID DENSITY: 1.89 at 20 C (Much heavier than Mustard)

APPEARANCE AND ODOR: Pure L is a colorless oily liquid. "War gas" is an amber to dark brown liquid. A characteristic odor is usually geranium-like; very little odor when pure.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT (Method Used): Does not flash

FLAMMABILITY LIMITS: N/A.

EXTINGUISHING MEDIA: Water, fog, foam, CO₂. Avoid use of extinguishing methods that will

cause splashing or spreading of L.

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be evacuated immediately. Fires involving L should be contained to prevent contamination of uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighter protective clothing (Without Tap Clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing (**See Section VIII**).



Do not breathe fumes. Skin contact with agents must be avoided always. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with the agent liquid or vapor can be fatal.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMITS (AEL): The permissible airborne exposure concentration of L for an 8-hour workday or a 40-hour work week is an 8-hour time weighted average (TWA) of 0.003 mg/m³ as a ceiling value. A ceiling value may not be exceeded anytime. The ceiling value for Lewisite is based upon the present technologically feasible detection limits of 0.003 mg/m³. This value can be found in "DA Pam 40-173, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard H, HD, HT, and L." To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated permissible exposure concentration for L.

EFFECTS OF OVEREXPOSURE: L is a vesicant (blister agent), also, it acts as a systemic poison, causing pulmonary edema, diarrhea, restlessness, weakness, subnormal temperature, and low blood pressure. In order of severity and appearance of symptoms, it is: a blister agent, a toxic lung irritant, absorbed in tissues, and a systemic poison. When inhaled in high concentrations, may be fatal in as short a time as 10 minutes. L is not detoxified by the body. Common routes of entry into the body include ocular, percutaneous, and inhalation.

TOXICOLOGICAL DATA:

Man:

LCt₅₀ (inhalation, man) = 1200 - 1500 mg min/m³
LCt₅₀ (skin vapor exposure, man) = 100,000 mg min/m³ LDLO (skin, human) = 20 mg/kg
LCt₅₀ (skin, man): >1500 mg/min³. L irritates eyes and skin and gives warning of its presence. Minimum effective dose (ED min) = 200 mg/m³ (30 min).
ICt₅₀ (eyes, man): < 300 mg min/m³.

Animal:

LD₅₀ (oral, rat) = 50 mg/kg
LD₅₀ (subcutaneous, rat) = 1 mg/kg
LCtLO (inhalation, mouse) = 150 mg/m³ 10m
LD₅₀ (skin, dog = 15 mg/kg RTECS) or 38 mg/kg (ERDEC chemical agent data sheets)
LD₅₀ (skin, rabbit) = 6 mg/kg
LD₅₀ (subcutaneous, rabbit) = 2 mg/kg
LD₅₀ (intravenous, rabbit) = 500 mg/kg
LD₅₀ (skin, guineapig) = 12 mg/kg
LD₅₀ (subcutaneous, guinea pig) = 1 mg/kg
LD₅₀ (skin, domestic farm animals) = 15 mg/kg

LCt50 (inhalation, rat) = 1500 mg min/m³ (9 min)
LCt50 (vapor skin, rat) = 20,000 mg min m 25 min)
LCD50 (skin, rat) = 15 - 24 mg/kg
LD50 (ip, dog) = 2 mg/kg
EDmin (skin, dog) = 50 mg/m³ (30 min)
EDmin (eye, dog) = 20 mg/m³ (30 min)
EDmin (skin, rabbit) = 25 mg/m³ (30 min)
EDmin (eye, rabbit) = 1 mg/m³ (30 min)

ACUTE EXPOSURE:

EYES: Severe damage. Instant pain, conjunctivitis and blepharospasm leading to closure of eyelids, followed by corneal scarring and iritis. Mild exposure produces reversible eye damage if decontaminated instantly. More permanent injury or blindness is possible within one minute of exposure.

SKIN: Immediate stinging pain increasing in severity with time. Erythema (skin reddening) appears within 30 minutes after exposure accompanied by pain with itching and irritation for 24 hours. Blisters appear within 12 hours after exposure with more pain that diminished after 2-3 days. Skin burns are much deeper than with HD. Tender skin, mucous membrane, and perspiration covered skin are more sensitive to the effects of lewisite. This, however, is counteracted by L's hydrolysis by moisture, producing less vesicant, higher vapor pressure product.

RESPIRATORY TRACT: Irritating to nasal passages and produces a burning sensation followed by profuse nasal secretion and violent sneezing. Prolonged exposure causes coughing and production of large quantities of froth mucus. In experimental animals, injury to respiratory tracts, due to vapor exposure is similar to mustard's; however, edema of the lung is more marked and frequently accompanied by pleural fluid.

SYSTEMIC EFFECTS: L on the skin, and inhaled vapor may cause systemic poisoning. A manifestation of this is a change in capillary permeability, which permit's loss of sufficient fluid from the bloodstream to cause hemoconcentration, shock and death. In nonfatal cases, hemolysis of erythrocytes has occurred with a resultant hemolytic anemia. The excretion of oxidized products into the bile by the liver produces focal necrosis of that organ, necrosis of the mucosa of the biliary passages with periobiliary hemorrhages, and some injury to the intestinal mucosa. Acute systematic poisoning from large skin burns cause's pulmonary edema, diarrhea, restlessness, weakness, subnormal temperature, and low blood pressure in animals.

CHRONIC EXPOSURE: Lewisite can cause sensitization and chronic lung impairment. Also, by comparison to agent mustard and arsenical compounds, it can be considered as a suspected human carcinogen.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Hold breath until respiratory protective mask is donned. Remove from the source IMMEDIATELY. If breathing has stopped give artificial respiration. Mouth-to-mouth resuscitation should be used when approved maskbag or oxygen system are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. Seek medical attention IMMEDIATELY.

EYE CONTACT: Speed in decontaminating the eyes is essential. Remove the person from the liquid source, flush the eyes immediately with water for at least 15 minutes tilting the head to the side, pulling eyelids apart with fingers and pouring water slowly into the eyes. Do not cover eyes with bandages, if necessary, protect eyes by means of dark or opaque goggles. Seek medical attention IMMEDIATELY.

SKIN CONTACT: Remove the victim from the source immediately and remove contaminated clothing. Immediately decon affected areas by flushing with 10% sodium carbonate solution or liquid household bleach within one minute. After 3-4 minutes, wash off with soap and water to protect against erythema. Seek medical attention IMMEDIATELY.

INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable in steel or glass containers.

INCOMPATIBILITY: Corrosive to steel at a rate of 1×10^{-5} to 5×10^{-5} in/month at 65 C.

HAZARDOUS DECOMPOSITION PRODUCTS: Reasonably stable; however, in presence of moisture, it hydrolyses rapidly, losing its vesicant property. It also hydrolyses in acidic medium to form HCl and non-volatile (solid) chlorovinylarsenious oxide, which is less vesicant than Lewisite. Hydrolysis in alkaline medium, as in decontamination with alcoholic caustic or carbonate solution or Decontaminating Agent, DS(DS2), produces acetylene and trisodium arsenate (Na_3AsO_4). Therefore, decontaminated solution would contain toxic arsenic.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Only personnel in full protective clothing (See Section VIII) will be allowed in area where L is spilled. See Section V for emergency and first aid procedures.

RECOMMENDED FIELD PROCEDURES: The L should be contained using vermiculite, diatomaceous earth, clay, or fine sand and neutralized as soon as possible using copious amounts of alcoholic caustic, carbonate, or DS2. Caution must be exercised when using these decontaminates since acetylene will be given off. Household bleach can also be used if accompanied by stirring to allow contact. Scoop up all contaminated material and clothing and place in approved DOT containers. Cover with additional decontaminant. Decontaminate the outside of the container and label according to DOT and EPA requirements. All leaking containers will be over packed with vermiculite placed between interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of as specified below. Dispose of decontaminate according to Federal, State, and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (See Sections II and VIII).

RECOMMENDED LABORATORY PROCEDURES: A 10 wt. % alcoholic sodium hydroxide solution is prepared by adding 100 grams of denatured ethanol to 900 grams of 10 wt.% NaOH in water. A minimum of 200 grams of decon is required for each gram of L. The decon/agent solution is agitated for a minimum of one hour. At the end of one hour the resulting pH should be checked and adjusted to above 11.5 using additional NaOH, if required. It is permitted to substitute 10 wt.% alcoholic sodium carbonate made and used in the same ratio as the NaOH listed above. Reaction time should be increased to 3-hours with agitation for the first hour. Final pH should be adjusted to above 10. It is permitted to substitute 5.25% sodium hypochlorite for the 10% alcoholic sodium hydroxide solution above. Allow one hour with agitation for the reaction. Adjustment of the pH is not required. Scoop up all contaminated material and place in an approved DOT container. Cover with additional decontaminant. Decontaminate the outside of the container and label according to DOT and EPA requirements. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of as specified below. Dispose of the decontaminate according to Federal, state, and local regulations. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (See Section VIII).

WASTE DISPOSAL METHOD: All neutralized material should be collected and contained for disposal according to land ban RCRA regulations or thermally decomposed in an EPA permitted incinerator equipped with a scrubber that will scrub out the chlorides and equipped with an electrostatic precipitator

or other filter device to remove arsenic. Collect all the arsenic dust from the electrostatic precipitator or other filter device and containerize and label according to DOT and EPA regulations. The arsenic will be disposed of according to land ban RCRA regulations. Any contaminated materials or protective clothing should be decontaminated using alcoholic caustic, carbonates, or bleach analyzed to assure it is free of detectable contamination (3X) level. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the DA issue point.

NOTE: Some states define decontaminated surety material as an RCRA hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

CONCENTRATION

RESPIRATORY PROTECTIVE EQUIPMENT.

< 0.003 mg/m³

A full face piece, chemical canister, air purifying protective mask will be on hand for escape. (The M9-, M17-, or M40-series masks are acceptable for this purpose. Other masks certified as equivalent may be used)

> 0.003 mg/m³ or unknown

A NIOSH/MSHA approved, full face piece SCBA suitable for use in high agent concentrations with a protective ensemble. (See DA Pam 385-61)

VENTILATION

Local exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentration to non-detectable level. Air emissions will meet local, state and federal regulations.

Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (1fpm) +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke producing devices will be performed in the assessment of the inclosure's ability to contain Lewisite.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hoods. Procedures should be developed for disposal of contaminated filters.

PROTECTIVE GLOVES: Norton, Chemical Protective Glove Set, Butyl Rubber Gloves M3 and M4

EYE PROTECTION: As a minimum, chemical goggles will be worn. For splash hazard use goggles and face-shield.

OTHER PROTECTIVE EQUIPMENT: For laboratory operations, wear lab coats, gloves and have a mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.

MONITORING: Available monitoring equipment for agent L is the M18A2 (yellow band), bubblers

(arsenic and GC method), and M256 & A1 Kits.

Real-time, low-level monitors (with alarm) are required for L operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When handling agents, the buddy system will be incorporated. No smoking, eating, or drinking in areas containing agents is permitted. Containers should be periodically inspected for leaks, either visually or using a detector kit. Stringent control over all personnel handling L must be exercised. Decontaminating equipment will be conveniently placed. Exits must be designed to permit rapid evacuation. Chemical showers, eye wash stations, and personal cleanliness facilities must be provided. Wash hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday.



OTHER PRECAUTIONS: L should be stored in containers made of glass for Research, Development Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent will be double contained in liquid and vapor tight containers when in storage or during transportation.

For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety Program," "DA Pam 385-61, Toxic Chemical Agent Safety Standards," and "DA Pam 40-173, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard H, HD, HT, and L."

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.

DOT HAZARDS CLASSIFICATION: 6.1, Packing Group I

DOT LABEL: Poison

DOT MARKING: Poisonous liquids, n.o.s. Dichloro-(2-chlorovinyl)arsine UN 2810

DOT PLACARD: POISON



EMERGENCY ACCIDENT PRECAUTIONS & PROCEDURES: See Sections IV, VII and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted according to AR 740-32.

While the Edgewood Research Development, and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development, and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be according to applicable Federal, State, and local laws and regulations.

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DATE: 1 May 1991

U.S. ARMY CHEMICAL
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER

Emergency Telephone #s:
CRDEC Safety Division
301-671-4411 0700-1700
EST After normal duty
hours: 301-278-5201
Ask for CRDEC Staff
Duty Officer

Nitrogen

Mustard - 1 (HN1)

MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND
CHEMICAL RESEARCH DEVELOPMENT AND ENGINEERING
CENTER

ATTN: SMCCR-CMS

ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: 538-07-8

CHEMICAL NAME: 2,2'-Dichlorotriethylamine

Alternate Chemical Names:

Ethylbis(beta-chloroethyl)amine

Ethylbis(2-chloroethyl)amine

2-Chloro-N-(2-chloroethyl)-N-ethylethanamine

TRADE NAME AND SYNONYMS: Ethyl-S

HN-1

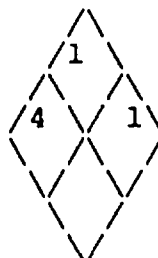
TL 329

TL 1149

CHEMICAL FAMILY: Chloroamino hydrocarbon

FORMULA/CHEMICAL STRUCTURE: (C1 CH2 CH2)2 NC2 H5

NFPA 704 SIGNAL: Health - 4
Flammability - 1
Reactivity - 1



SECTION II - COMPOSITION

INGREDIENTS

FORMULA

PERCENTAGE

AIRBORNE

NAME		BY WEIGHT	EXPOSURE LIMIT
Nitrogen Standard 1	(Cl CH2 CH2)2 NC2 H5	100	*

* None established/available

SECTION III - PHYSICAL DATA

BOILING POINT DEG F (DEG C): 150.8 (66) at 3 torr
 185.9 (88.5) at 12 torr
 381.2 (194) at 760 torr (Calculated)
 Decomposes before boiling at 760 torr.

VAPOR PRESSURE (mm Hg): 0.0773 at 10 DEG C
 0.25 at 25 DEG C
 0.744 at 40 DEG C

VAPOR DENSITY (AIR=1): 5.9

SOLUBILITY IN WATER: Miscible with many organic solvents and oils.
 Very slightly soluble in water.

SPECIFIC GRAVITY (H2O=1): 1.0861 at 23 DEG C
 1.09 at 25 DEG C

FREEZING (MELTING) POINT: -34 DEG C

AUTOIGNITION TEMPERATURE DEG F (DEG C): Data not available

VISCOSITY (CENTISTOKES): Data not available

VOLATILITY: 127 mg/m3 at -10 DEG C
 308 mg/m3 at 0 DEG C
 744 mg/m3 at 10 DEG C
 1520 mg/m3 at 20 DEG C
 2290 mg/m3 at 25 DEG C
 3100 mg/m3 at 30 DEG C
 6290 mg/m3 at 40 DEG C

EVAPORATION RATE: Data not available

APPEARANCE & ODOR: Pale amber to yellow oily liquid; Faint "fishy" or
 "musty" odor.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: No immediate danger of fire or explosion.

FLAMMABILITY LIMITS (% by volume): Data not available

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing
 the fire should be immediately evacuated from the area. Fires involving

HN1 should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. The M9 or M17 series mask may be worn in lieu of SCBA when there is no danger of oxygen deficiency. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8). Skin contact and inhalation of HN2 and its vapors must be avoided at all times. Contact may be fatal.

EXTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid use of extinguishing methods that will splash or spread HN1.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Vapors of unburned agent will exhibit toxic effects.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMIT (AEL): An AEL is not available for HN1. No individual should be exposed to any direct skin or eye contact or any detectable airborne concentrations. Airborne exposure should be controlled to the lowest feasible limit. The following information is based upon the limited available information and the chemical similarity to HD. The AEL for HD is 0.3 mg/m3 as proposed in the USAEHA Technical Guide No. 173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT". The Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for HN1. Nitrogen mustards are classified as carcinogens by the International Agency for Research on Cancer (IARC).

EFFECTS OF OVEREXPOSURE: The vapors are irritating to the eyes and nasal membranes even in low concentration. HN1 is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues. HN1 is not naturally detoxified by the body, therefore repeated exposure produces a cumulative effect.

Median lethal dosages of HN1 in man are the following:

LCt50 (man, inhalation) = 1500 mg-min/m3
LCt50 (man, percutaneous vapor) = 20,000 mg-min/m3

Median incapacitating dosages of HN1 in man are the following:

ICt50 (man, eye contact) = 200 mg-min/m3
ICt50 (man, percutaneous) = 9000 mg-min/m3

Vesicancy doses in man are the following:

Liquid:

43.6 microliters produced 28 percent erythema
218 microliters produced 72 percent erythema

218 microliters produced 20 percent erythema

ROUTE PHYSIOLOGICAL ACTION OF HN1 IS LOCAL AND SYSTEMIC:

Locally, HN1 affects both the eyes and the skin. Skin damage occurs after percutaneous resorption. Skin penetration is rapid and skin irritation is noted very shortly after contact with the agent. Reddening (erythema) of the skin may occur within 30 minutes to 1 hour following the exposure, depending on degree of exposure and individual sensitivity. Blistering may not occur for more than 12 hours following exposure. Tender skin, mucous membrane and perspiration covered skin are more sensitive to the effects of HN1. Local action on the eyes is extremely rapid, and produces severe neurotic damage and loss of eyesight. Exposure of eyes to HN1 vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea. Greatest immediate effect on HN1 is on the eyes.

Systemic actions occur primarily through inhalation and ingestion. When inhaled, the lesions caused by nitrogen mustards are similar to those caused by mustards. They decrease in severity down the respiratory tract from the point of entry. The upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing, hoarseness progressing to loss of voice, and persistent cough. Fever and moist rashes develop followed by loss of appetite, diarrhea, and apathy. Broncho pneumonia may appear after the first twenty four hours. Exposure to near lethal doses of HN1 can produce injury to bone marrow, lymph nodes, and spleen as indicated by a drop in WBC count, and results in increased susceptibility to local and systemic infections. Ingestion of HN1 will produce severe stomach pains, vomiting and bloody stools.

Chronic exposure to HN1 can cause sensitization and chronic lung impairment (cough, shortness of breath, chest pain). In mild vapor exposures there may be no skin lesions. After severe exposure or after exposure to liquid nitrogen mustard, reddening may appear earlier than in mustard contamination. There may be irritation and itching as with mustard; blisters may appear later. However, blisters may not occur for more than 12 hours following exposure. Skin lesions are similar to those caused by mustard.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

EYE CONTACT: Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the patient to a medical facility IMMEDIATELY.

SKIN CONTACT: Don respiratory protective mask and gloves; remove victim from source immediately. Flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5 percent sodium hypochlorite solution, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility IMMEDIATELY.

INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Polymerizes slowly

INCOMPATIBILITY: Corrosive to ferrous alloys beginning at 65 DEG C (149 DEG F)

HAZARDOUS DECOMPOSITION: Toxic intermediate products are produced during hydrolysis. Approximate half-life in water at 25 DEG C in 1.3 minutes. Decomposition comes through slow change into quaternary ammonium salts. Decomposition point is below 194 DEG C (381.2 DEG F).

HAZARDOUS POLYMERIZATION: Slowly

RATE OF HYDROLYSIS: Slow

HYDROLYSIS PRODUCTS: Hydroxyl derivatives and condensation products.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Only personnel full protective clothing will be allowed in an area where HN1 is spilled.

RECOMMENDED FIELD PROCEDURES:

It should be contained using vermiculite, diatomaceous earth, clay or fine sand and neutralized as soon as possible using copious amounts of 5.25 percent sodium hypochlorite solution.

Scoop up all material and place in an approved DOT container. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of the material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

If 5.25 percent sodium hypochlorite solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Calcium Hypochlorite, Decontamination Solution No. 2 (DS2), and Super Tropical Bleach Slurry (STB). WARNING: Pure, undiluted Calcium Hypochlorite (HTH) will burn on contact with liquid blister agent.

RECOMMENDED LABORATORY PROCEDURES: A minimum of 65 grams of decon solution (5.25% Sodium Hypochlorite solution) is required for each gram of HN1. HN1 must be added to the decon solution and NOT DECON SOLUTION TO HN1. Decontamination/agent solution is allowed to agitate for a minimum of one

hour. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 hours, the resulting solution shall be adjusted to a pH between 10 to 11. Test for presence of active chlorine by adding a few drops of acidic potassium iodide solution to give free iodine color. Place 3 ml of the decontaminate in a test tube. Add several crystals of potassium iodine and swirl to dissolve. Add 3 ml of 50 wt % sulfuric acid:water and swirl. IMMEDIATE iodine color indicates the presence of active chlorine. If negative, add additional 5.25% sodium hypochlorite solution to the decontamination solution, wait two hours, then test again for active chlorine. Continue procedure until positive chlorine is given by solution.

A 10 wt % HTH mixture may be substituted for sodium hypochlorite. Use 65 grams of decon per gram of HN1 and continue the test as described for sodium hypochlorite.

Do not use dry STB or HTH as they react violently with some chemicals. Scoop up all material and place in an approved DOT container. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of the material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

NOTE: Surfaces contaminated with HN1 and then rinsed with water may evolve sufficient HN1 vapor to produce a physiological response.

WASTE DISPOSAL METHOD: All decontaminated material should be collected, contained, and chemically decontaminated, then thermally decomposed in an approved incinerator for HN1, which will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated protective clothing should be decontaminated using HTH or bleach and analyzed to assure it is free of detectable contamination. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the Department of Army issue point. Decontamination of waste or excess material shall be accomplished in accordance with the following procedure:

--- HN1 on laboratory glassware may be oxidized reacting it with strong bleaches, alkalies, or other oxidizers.

Decontaminated waste and/or HN1 shall be transported according to local SOP (in accordance with AR 55-355). Final disposition will be controlled according to AMCR 385-131 and APG 200-2 and RCRA state regulations which take precedence (NOTE: Some states consider certain decontaminated surety agents as RCRA hazardous waste. Local regulations must be considered before disposal action is taken).

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

1 Concentration

Less than or equal
to 0.003 mg/m³ as
an 8-hr TWA

Respiratory Protective Equipment

Protective mask not required provided
that:

- (a) Continuous real-time monitoring (with alarm capability) is conducted in the work area at the 0.003 mg/m³ level of detection.
- (b) M9, M17 or M40 mask is available and donned if concentrations exceed 0.003 mg/m³.
- (c) Exposure has been limited to the extent practicable by engineering control (remote operations, ventilations, and process isolation) or work practices.

If those conditions are not met then the following applies:

Full facepiece, chemical canister, air-purifying respirators. (The M9, M17 or M40 series or other certified equivalent masks acceptable for this purpose in conjunction with the M3 toxicological agent protective (TAP) suit for dermal protection.)

Greater than 0.003
as an 8-hr TWA

The Demilitarization Protective Ensemble (DPE), 30 mil, may be used with prior approval from the AMC Field Safety Activity. Use time for the 30 mil DPE must be restricted to two hours or less.

NOTE: When 30 mil DPE is not available the M17 or M40 mask with Level A protective ensemble including impregnated innerwear can be used. However, use time shall be restricted to the extent operationally feasible, and may not exceed one hour.

As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots to reduce aspiration.

VENTILATION: Local exhaust: Mandatory must be filtered or scrubbed.

SPECIAL: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located such that cross drafts do not ex-

ceed 20 % of the inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in the assessment of the enclosure's ability to contain agent HN1.

Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent areas and other areas through ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hoods.

PROTECTIVE GLOVES: Mandatory - Butyl Toxicological Agent Protective Gloves (M3, M4, or glove set).

EYE PROTECTION: Chemical goggles. When there is potential for severe exposure (e.g., sampling pressurized system, loading and unloading operations) chemical goggles and full face shield are recommended.

OTHER PROTECTIVE EQUIPMENT: Full protective clothing will consist of the M3 butyl rubber suit with hood, M2A1 boots, M3 gloves, underwear, M9 series mask and coveralls (if desired), STEPO I or the DPE. For general lab work, gloves and lab coat shall be worn with M9, M17, or M40 mask readily available.

In addition, when handling contaminated lab animals wearing clean smock, foot covers, and head covers are required daily.

MONITORING: Data not available.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: During handling, the "buddy" (two man) system will be used. Containers should be periodically inspected for leaks (either visually or by a detector kit), and prior to transferring the containers from storage to work areas. Stringent control over all personnel handling HN1 must be exercised. Chemical showers, eye-wash stations, and personal cleanliness facilities must be provided. Each worker will wash their hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap before leaving at the end of the workday. No smoking, eating, or drinking is permitted at the work site. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. HN1 should be stored in containers made of glass for Research, Development Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid tight containers when in storage.

OTHER PRECAUTIONS: For additional information see AMCR 385-131, "Safety Regulations for Chemical Agents H, HD, HT, GB, and VX" and USAEHA Technical Guide No. 173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT".

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquid, n.o.s.

DOT HAZARD CLASSIFICATION: Poison A

DOT LABEL: Poison Gas

MARKING: Poison Liquid, n.o.s. (2,2'-Dichlorotriethylamine) NA 1955

DOT PLACARD: POISON GAS

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. All shipments will be handled per local SOP (AR 55-355). Shipment of agents will be escorted in accordance with AR 740-32.

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See sections IV, VII, and VIII.

While the Chemical Research, Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Chemical Research, Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable federal, State, and local laws and regulations.

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PRODUCT #: T85308 NAME: TRIS(2-CHLOROETHYL)AMINE HYDROCHLORIDE,
MATERIAL SAFETY DATA SHEET, Valid 5/96 - 7/96
Printed Thursday, July 11, 1996 1:12PM

Sigma Chemical Co.	Aldrich Chemical Co., Inc.	Fluka Chemical Corp
P.O. Box 14508	1001 West St. Paul	980 South Second St
St. Louis, MO 63178	Milwaukee, WI 53233	Ronkonkoma, NY 1177
Phone: 314-771-5765	Phone: 414-273-3850	Phone: 516-467-0980
		Emergency Phone: 516-467-3535

SECTION 1. - - - - - CHEMICAL IDENTIFICATION- - - - -

CATALOG #: T85308
NAME: TRIS(2-CHLOROETHYL)AMINE HYDROCHLORIDE,
98%

SECTION 2. - - - - - COMPOSITION/INFORMATION ON INGREDIENTS - - - - -

CAS #: 817-09-4
MF: C6H12CL3N
EC NO: 212-442-3

SYNONYMS

ETHANAMINE, 2-CHLORO-N,N-BIS(2-CHLOROETHYL)-, HYDROCHLORIDE (9CI) *
HN3 HYDROCHLORIDE * LEKAMIN * NSC-30211 * R-47 * SINALOST * SK-100 *
TRICHLORMETHINE * TRICHLORMETHINIUM CHLORIDE * TRI(BETA-CHLOROETHYL)
AMINE HYDROCHLORIDE * TRI-(2-CHLOROETHYL)AMINE HYDROCHLORIDE * 2,2',
2''-TRICHLOROTRIETHYLAMINE HYDROCHLORIDE * TRICHLOR-TRIAETHYLAMIN-
HYDROCHLORID (GERMAN) * TRILLEKAMIN * TRIMITAN * TRIMUSTINE *
TRIMUSTINE HYDROCHLORIDE * TRIS(BETA-CHLOROETHYL)AMINE HYDROCHLORIDE *
TRIS(2-CHLOROETHYL)AMINE HYDROCHLORIDE * TRIS(2-CHLOROETHYL)AMINE
MONOHYDROCHLORIDE * TRIS(2-CHLOROETHYL)AMMONIUM CHLORIDE * TRIS-N-
LOST (GERMAN) * TS-160 *

SECTION 3. - - - - - HAZARDS IDENTIFICATION - - - - -

LABEL PRECAUTIONARY STATEMENTS

HIGHLY TOXIC (USA DEFINITION)
VERY TOXIC (EUROPEAN DEFINITION)
MAY CAUSE CANCER.
MAY CAUSE HERITABLE GENETIC DAMAGE.
VERY TOXIC BY INHALATION, IN CONTACT WITH SKIN AND IF SWALLOWED.
CAUSES BURNS.
MUTAGEN.
VESICANT.
CAUSES BLISTERS ON CONTACT WITH SKIN.
IN CASE OF ACCIDENT OR IF YOU FEEL UNWELL, SEEK MEDICAL ADVICE
IMMEDIATELY (SHOW THE LABEL WHERE POSSIBLE).
IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF
WATER AND SEEK MEDICAL ADVICE.
TAKE OFF IMMEDIATELY ALL CONTAMINATED CLOTHING.

DO NOT BREATHE DUST.

AFTER CONTACT WITH SKIN, WASH IMMEDIATELY WITH PLENTY OF WATER.

WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE
PROTECTION.

SECTION 4. - - - - - FIRST-AID MEASURES- - - - -

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS
AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED
CLOTHING AND SHOES.

ASSURE ADEQUATE FLUSHING OF THE EYES BY SEPARATING THE EYELIDS
WITH FINGERS.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL
RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS.
CALL A PHYSICIAN IMMEDIATELY.

SECTION 5. - - - - - FIRE FIGHTING MEASURES - - - - -

EXTINGUISHING MEDIA

WATER SPRAY.

CARBON DIOXIDE, DRY CHEMICAL POWDER OR APPROPRIATE FOAM.

SPECIAL FIREFIGHTING PROCEDURES

WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO
PREVENT CONTACT WITH SKIN AND EYES.

UNUSUAL FIRE AND EXPLOSIONS HAZARDS

EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

SECTION 6. - - - - - ACCIDENTAL RELEASE MEASURES- - - - -

EVACUATE AREA.

WEAR SELF-CONTAINED BREATHING APPARATUS, RUBBER BOOTS AND HEAVY
RUBBER GLOVES.

WEAR DISPOSABLE COVERALLS AND DISCARD THEM AFTER USE.

SWEEP UP, PLACE IN A BAG AND HOLD FOR WASTE DISPOSAL.

AVOID RAISING DUST.

VENTILATE AREA AND WASH SPILL SITE AFTER MATERIAL PICKUP IS COMPLETE.

SECTION 7. - - - - - HANDLING AND STORAGE- - - - -

REFER TO SECTION 8.

SECTION 8. - - - - - EXPOSURE CONTROLS/PERSONAL PROTECTION- - - - -

WEAR APPROPRIATE NIOSH/MSHA-APPROVED RESPIRATOR, CHEMICAL-RESISTANT
GLOVES, SAFETY GOGGLES, OTHER PROTECTIVE CLOTHING.

SAFETY SHOWER AND EYE BATH.

USE ONLY IN A CHEMICAL FUME HOOD.

FACESHIELD (8-INCH MINIMUM).

DO NOT BREATHE DUST.

DO NOT GET IN EYES, ON SKIN, ON CLOTHING.

AVOID PROLONGED OR REPEATED EXPOSURE.

WASH THOROUGHLY AFTER HANDLING.

HIGHLY TOXIC.
CORROSIVE.
VESICANT.
CARCINOGEN.
MUTAGEN.
KEEP TIGHTLY CLOSED.
STORE IN A COOL DRY PLACE.

SECTION 9. - - - - - PHYSICAL AND CHEMICAL PROPERTIES - - - - -

APPEARANCE AND ODOR

OFF WHITE CRYSTALLINE POWDER

PHYSICAL PROPERTIES

MELTING POINT: 127 C TO 130 C

SECTION 10. - - - - - STABILITY AND REACTIVITY - - - - -

INCOMPATIBILITIES

STRONG OXIDIZING AGENTS

STRONG BASES

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

TOXIC FUMES OF:

CARBON MONOXIDE, CARBON DIOXIDE

NITROGEN OXIDES

HYDROGEN CHLORIDE GAS

SECTION 11. - - - - - TOXICOLOGICAL INFORMATION - - - - -

ACUTE EFFECTS

MAY BE FATAL IF INHALED, SWALLOWED, OR ABSORBED THROUGH SKIN.

CAUSES BLISTERS ON CONTACT WITH SKIN.

DEPENDING ON THE INTENSITY AND DURATION OF EXPOSURE, EFFECTS MAY VARY FROM MILD IRRITATION TO SEVERE DESTRUCTION OF TISSUE.

SYMPTOMS OF EXPOSURE MAY INCLUDE BURNING SENSATION, COUGHING, WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HEADACHE, NAUSEA AND VOMITING.

CHRONIC EFFECTS

CARCINOGEN.

MAY ALTER GENETIC MATERIAL.

TO THE BEST OF OUR KNOWLEDGE, THE CHEMICAL, PHYSICAL, AND

TOXICOLOGICAL PROPERTIES HAVE NOT BEEN THOROUGHLY INVESTIGATED.

RTECS #: YE2800000

TRIETHYLAMINE, 2,2',2''-TRICHLORO-, HYDROCHLORIDE

TOXICITY DATA

IPR-RAT LD50:750 UG/KG

CPBTAL 8,807,60

SCU-RAT LD50:2 MG/KG

NTIS** PB158-507

IVN-RAT LD50:700 UG/KG

NTIS** PB158-507

CPL-MUS LD50:1100 UG/KG

ARZNAD 9,595,59

IPR-MUS LD50:1600 UG/KG

AEPPAE 230,559,57

SCU-MUS LD50:2 MG/KG
IVN-RBT LD50:2500 UG/KG

JPETAB 91,224,47
JPETAB 91,224,47

TARGET ORGAN DATA

BEHAVIORAL (SOMNOLENCE)
BEHAVIORAL (ANOREXIA, HUMAN)
BEHAVIORAL (HEADACHE)
VASCULAR (THROMBOBOSIS DISTANT FROM INJECTION SITE)
LUNGS, THORAX OR RESPIRATION (TUMORS)
GASTROINTESTINAL (CHANGES IN STRUCTURE OR FUNCTION OF SALIVARY GLANDS)
GASTROINTESTINAL (ULCERATION OR BLEEDING FROM SMALL INTESTINE)
GASTROINTESTINAL (HYPERMOTILITY, DIARRHEA)
GASTROINTESTINAL (NAUSEA OR VOMITING)
BLOOD (LUEKOPENIA)
PATERAL EFFECTS (SPERMATOGENESIS)
PATERAL EFFECTS (TESTES, EPIDIDYMISS, SPERM DUCT)
TUMORIGENIC (CARCINOGENIC BY RTECS CRITERIA)
TUMORIGENIC (TUMORS AT SITE OF APPLICATION)
TUMORIGENIC (ACTIVE AS ANTI-CANCER AGENT)
ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES
(RTECS) DATA IS PRESENTED HERE. SEE ACTUAL ENTRY IN RTECS FOR
COMPLETE INFORMATION.

SECTION 12. - - - - - ECOLOGICAL INFORMATION - - - - -
DATA NOT YET AVAILABLE.

SECTION 13. - - - - - DISPOSAL CONSIDERATIONS - - - - -
DISSOLVE OR MIX THE MATERIAL WITH A COMBUSTIBLE SOLVENT AND BURN IN A
CHEMICAL INCINERATOR EQUIPPED WITH AN AFTERBURNER AND SCRUBBER.
OBSERVE ALL FEDERAL, STATE AND LOCAL ENVIRONMENTAL REGULATIONS.

SECTION 14. - - - - - TRANSPORT INFORMATION - - - - -
CONTACT ALDRICH CHEMICAL COMPANY FOR TRANSPORTATION INFORMATION.

SECTION 15. - - - - - REGULATORY INFORMATION - - - - -

EUROPEAN INFORMATION

VERY TOXIC
R 45
MAY CAUSE CANCER.
R 46
MAY CAUSE HERITABLE GENETIC DAMAGE.
R 26/27/28
VERY TOXIC BY INHALATION, IN CONTACT WITH SKIN AND IF SWALLOWED.
R 34
CAUSES BURNS.
S 45
IN CASE OF ACCIDENT OR IF YOU FEEL UNWELL, SEEK MEDICAL ADVICE
IMMEDIATELY (SHOW THE LABEL WHERE POSSIBLE).

S 26

IN CASE OF CONTACT WITH EYES, RINSE IMMEDIATELY WITH PLENTY OF WATER AND SEEK MEDICAL ADVICE.

S 27

TAKE OFF IMMEDIATELY ALL CONTAMINATED CLOTHING.

S 22

DO NOT BREATHE DUST.

S 28

AFTER CONTACT WITH SKIN, WASH IMMEDIATELY WITH PLENTY OF WATER.

S 36/37/39

WEAR SUITABLE PROTECTIVE CLOTHING, GLOVES AND EYE/FACE PROTECTION.

REVIEWS, STANDARDS, AND REGULATIONS

OEL=MAK

IARC CANCER REVIEW:ANIMAL SUFFICIENT EVIDENCE IMEMDT 50,143,90

IARC CANCER REVIEW:ANIMAL INADEQUATE EVIDENCE IMEMDT 9,229,75

IARC CANCER REVIEW:HUMAN NO ADEQUATE DATA IMEMDT 9,229,75

IARC CANCER REVIEW:HUMAN NO ADEQUATE DATA IMEMDT 50,143,90

IARC CANCER REVIEW:GROUP 2B IMEMDT 50,143,90

EPA GENETOX PROGRAM 1988, POSITIVE: S POMBE-REVERSION

SECTION 16. - - - - - OTHER INFORMATION- - - - -

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. SIGMA, ALDRICH, FLUKA SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE.

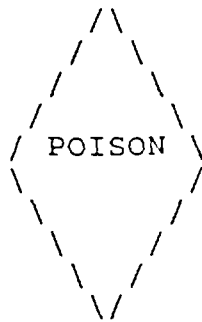
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REVISED: 30 June 95
DATE: 26 September 1988



U.S. ARMY EDGEWOOD
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER

Emergency Telephone #s:
ERDEC Safety Office
410-671-4411 0700-1700
EST After normal duty
hours: 410-671-2148
Ask for ERDEC Staff
Duty Officer

HL

MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY CHEMICAL AND BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH, DEVELOPMENT AND ENGINEERING
CENTER
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: Not Available

CHEMICAL NAME: None - Mixture of Sulfur Mustard and Lewisite

Alternate chemical names: None; See Components

TRADE NAME AND SYNONYMS:

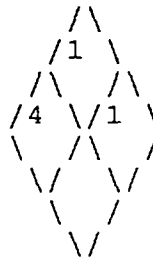
HL
Sulfur Mustard/Lewisite (Vesicant)

CHEMICAL FAMILY: Mixture of chlorinated sulfur compound and organoarsenic compound

FORMULA/CHEMICAL STRUCTURE: Eutectic Mixture of 37.1% Sulfur Mustard (HD)
and 62.9% Lewisite (L)

HD: C1 CH2 CH2 SCH2 CH2 C1
L: C2 H2 As C13

NFPA 704 SIGNAL: Health - 4
Flammability - 1
Reactivity - 1



SECTION II - COMPOSITION

INGREDIENTS	FORMULA	PERCENTAGE	AIRBORNE
-------------	---------	------------	----------

NAME		BY WEIGHT	EXPOSURE LIMIT (AEL)
HD	(Cl C2 H4)S	37.1	0.003 mg/m3
Lewisite	C2 H2 As Cl3	62.9	*0.003 mg/m3

* This is a ceiling value.

SECTION III - PHYSICAL DATA

BOILING POINT DEG F (DEG C): Indefinite, but below 190 DEG C

VAPOR PRESSURE (torr): 0.248 @ 20 DEG C

VAPOR DENSITY (AIR=1): 6.5

SOLUBILITY IN WATER: Practically insoluble

SPECIFIC GRAVITY (H2O=1): 1.60 at 20 DEG C (calculated)

FREEZING (MELTING) POINT: -25.4 DEG C (purified agent mix)
-42 DEG C (typical production batch)

AUTOIGNITION TEMPERATURE DEG F (DEG C): Data not available

VISCOSITY (CENTISTOKES): 1.6 Centistokes @ 20 DEG C

VOLATILITY (mg/liter): 3.90 at 25 DEG C (calculated)

EVAPORATION RATE: Data not available

APPEARANCE & ODOR: Odor: Garlic-like (from HD)
Appearance: Dark oily liquid

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: (METHOD USED): High enough not to interfere with military use

FLAMMABILITY LIMITS (% by volume): Data not available

EXTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid use of extinguishing methods that will splash or spread mustard.

UNUSUAL FIRE & EXPLOSION HAZARDS: Toxic fumes of hydrogen chloride, sulfur oxides, and arsenic may be produced in a fire. Vapors of unburned agent will exhibit toxic effects.

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving HL should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, fire-fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or

chemical accident/incident (CAI) operations officer. In cases where fire-fighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMIT: Since HL contains HD, a carcinogen and mutagen, airborne exposure should be controlled to the lowest feasible limit. No individual should be intentionally exposed to any direct skin or eye contact. The AEL for HD is 0.003 mg/m³ as an 8 hour time weighted average (TWA) as found in DA Pam 40-173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT". HL also contains Lewisite which is a suspected carcinogen and has a ceiling value of 0.003 mg/m³.

EFFECTS OF OVEREXPOSURE: HL is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. The rate of detoxification of HL in the body is very slow and repeated exposure produces a cumulative effect. Median lethal dosages (LCt50) of HL for man are the following:

Inhalation: about 1500 mg-min/m³
Skin Absorption: Above 10,000 mg-min/m³

Median incapacitating dosages (ICt50) of HL for man are the following:

Eye Injury: about 200 mg-min/m³
Skin Absorption: 1500 to 2000 mg-min/m³

ACUTE PHYSIOLOGICAL ACTION OF HL IS CLASSIFIED AS LOCAL AND SYSTEMIC.

LOCALLY, HL affects both the eyes and the skin. SKIN damage occurs after percutaneous resorption. Being lipid soluble, HL can be resorbed into all organs. Skin penetration is rapid and skin irritation is noted very shortly after contact with the agent. Reddening (erythema) of the skin occurs within 30 minutes following the exposure, depending on degree of exposure and individual sensitivity. Blisters appear 4-24 hours following exposure. Blisters from HL exposures are deeper and more painful than with HD. The skin healing process is very slow. Tender skin, mucous membrane and perspiration covered skin are more sensitive to the effects of HL. Local action on the eyes is extremely rapid, and produces severe necrotic damage and loss of eyesight. Exposure of eyes to HL vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea.

SYSTEMIC ACTIONS occur primarily through inhalation and ingestion. The HL vapor/aerosol is less toxic to both the skin and eyes. When inhaled, the upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, loss of appetite, diarrhea, fever, and apathy. Exposure to nearly lethal doses of HL can produce injury to bone marrow, lymph nodes, and spleen as indicated by a drop in WBC count and, therefore, results in increased susceptibility to local and systemic infections. Ingestion of HL will produce severe stomach pains, vomiting, and bloody stools after a 15-20 minute latency period.

CHRONIC EXPOSURE to HL can cause sensitization, chronic lung impairment, (cough, shortness of breath, chest pain), and cancer of the mouth, throat, respiratory tract, skin, and leukemia. It may also cause birth defects.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

EYE CONTACT: Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the patient to a medical facility IMMEDIATELY.

SKIN CONTACT: Don respiratory protective mask and gloves; remove victim from agent source immediately. Flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5 percent sodium hypochlorite solution, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility.

INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable at ambient temperatures. HL is a persistent agent depending on pH and moisture, and has been known to remain active for up to three years in soil.

INCOMPATIBILITY: Conditions to avoid. Rapidly corrosive to brass @ 65 DEG C. Will corrode steel at a rate of .0001 inches of steel per month @ 65 DEG C.

HAZARDOUS DECOMPOSITION: HL will hydrolyze into HCL, thiodiglycol, and non-vesicant arsenic compound.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Only personnel in full protective clothing will be allowed in an area where HL is spilled. HL should be contained using vermiculite, diatomaceous earth, clay or fine sand and neutralized as soon as possible using copious amounts of STB slurry or HTH solution. Never use dry STB or HTH since they will react violently with HL and may burst into flames. Scoop up all contaminated material and place in approved DOT container. Pour in STB slurry or HTH solution. Decontaminate the outside of the containers and overpack with a larger container pouring vermiculite or other absorbent material in between the two drums. Label in accordance with state, DOT and EPA regulations and hold for disposal. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Section 2 and 8).

NOTE: Surfaces contaminated with HL and then rinse-decontaminated may evolve

sufficient HL vapor to produce a physiological response.

WASTE DISPOSAL METHOD: All neutralized material should be collected, contained and thermally decomposed in an EPA permitted incinerator for decontaminated HL (see note) and arsenicals. Any contaminated protective clothing should be decontaminated using HTH or bleach and analyzed to assure it is free of detectable contamination (3X) level. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the DA issue point. Decontamination of waste or excess material shall be accomplished in accordance with the following procedure:

(a) HL on laboratory glassware may be destroyed by its vigorous reaction with concentrated nitric acid.

(b) Chemical neutralization of HL may be accomplished by adding it to an excess of 60/40 slurry of STB or HTH solid bleach and water. HL has poor solubility in water. The HL-bleach slurry must be stirred frequently over 24 hours to assure that the HL has contacted and reacted with the bleach. After 24 hours, test for the presence of active chlorine in the decon slurry before discarding.

Note: Some states consider certain decontaminated surety agents as RCRA hazardous waste. Local regulations must be considered before disposal action is taken.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

Respiratory protection equipment is based on that of Agent HD.

Concentration (mg/m³)

Respiratory Protection/Ensemble Required

Less than or equal
to 0.003 as an
8-hr TWA

Protective mask not required provided that:

- (a) Continuous real-time monitoring (with alarm capability) is conducted in the work area at the 0.003 mg/m³ level of detection.
- (b) M9, M17 or M40 mask is available and donned if excursion concentrations exceed 0.003 mg/m³.
- (c) Exposure has been limited to the extent practicable by engineering controls (remote operations, ventilation, and process isolation) or work practices.

If these conditions are not met then the following applies:

Full facepiece, chemical canister, air-purifying respirators. (The M9, M17, or M40 series or other certified equivalent masks are acceptable for this purpose in conjunction with the M3 toxicological agent protective (TAP) suit for dermal protection.)

Greater than
0.003 as an
8-hr TWA

NIOSH/MSHA approved pressure demand full
facepiece SCBA suitable for use in high agent
concentrations with protective ensemble.
(See DA Pam 385-61 for examples)

VENTILATION: Local exhaust - Mandatory. Must be filtered or scrubbed.
Air emissions shall meet local, state and federal regulations.

Special. Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods shall have an inward face velocity of 150 lfpm plus or minus 20%. Laboratory hoods shall be located such that cross drafts do not exceed 20% of inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in assessing the ability of the hood to contain agent HL.

Other. Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hoods.

PROTECTIVE GLOVES: MANDATORY. Butyl Toxicological Agent Protective gloves (M3, M4, or glove set).

EYE PROTECTION: As a minimum, chemical goggles will be worn. For splash hazard use goggles and face-shield.

OTHER PROTECTIVE EQUIPMENT: For general lab work, gloves and lab coat shall be worn with M9, M40 or M17 mask readily available.

In addition, when handling contaminated lab animals, a daily clean smock, foot covers, and head covers are required.

MONITORING: Real Time Analytical Platform (RTAP)

Real-time, low-level monitors (with alarm) are required for HL operations. In their absence, an IDLH atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: During handling, the "buddy" (two-man) system will be used. Containers should be periodically inspected for leaks, either visually or using a detector kit, and prior to transferring the containers from storage to work areas. Stringent control over all personnel handling HL must be exercised. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Each worker will wash their hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap before leaving at the end of the work day. No smoking, eating, or drinking is permitted at the work site. Decontamination equipment shall be conveniently located. Kits must be designed to permit rapid evacuation. HL should be stored in containers made of glass for Research Development Test and Evaluation (RDTE)

quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-tight containers when in storage.

OTHER PRECAUTIONS: For additional information see AR 385-61, "The Army Toxic Chemical Agent Safety Program", DA Pam 385-61, "Toxic Chemical Agent Safety Standards", and DA Pam 40-173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT".

SECTION X - TRANSPORTATION DATA

FORBIDDEN FOR TRANSPORT OTHER THAN VIA MILITARY (TECHNICAL ESCORT UNIT)
TRANSPORT AS PER 49 CFR 172

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.

DOT HAZARD CLASSIFICATION: 6.1, Packing Group I, Hazard Zone B

DOT LABEL: Poison

DOT MARKING: Poisonous liquids, n.o.s. (Sulfur Mustard/Lewisite) UN 2810,
Inhalation Hazard

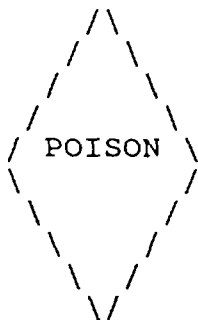
DOT PLACARD: POISON

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted in accordance with AR 740-32.

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See sections IV, VII, and VIII.

While the Edgewood Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

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REVISED: 30 June 95
DATE: 26 September 1988

U.S. ARMY EDGEWOOD
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER

Emergency Telephone #s:
ERDEC Safety Office
410-671-4411 0700-1700
EST After normal duty
hours: 410-671-2148
Ask for ERDEC Staff
Duty Officer

HQ

MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY CHEMICAL AND BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH DEVELOPMENT AND ENGINEERING
CENTER
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: Not Available

CHEMICAL NAME: Mixture of 75% bis-(2-Chloroethyl) sulfide (HD) and 25%
1,2-bis-(2-chloroethylthio)ethane (Q)

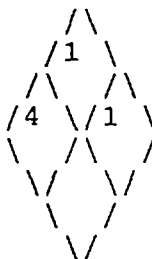
DE NAME AND SYNONYMS:

HQ
Sulfur-Mustard/Sesqui-Mustard (Vesicant)

CHEMICAL FAMILY: Chlorinated sulfur compound

FORMULA/CHEMICAL STRUCTURE: Mixture of 25% Sesquimustard (Q) and 75%
Sulfur Mustard (HD)

NFPA 704 SIGNAL: Health - 4
Flammability - 1
Reactivity - 1



SECTION II - COMPOSITION

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
HD	C ₄ (H ₈)C ₁₂ (S)	75	0.003 mg/m ³ (8-hr TWA)
Q	C ₆ (H ₁₂)C ₁₂ (S ₂)	25	*

NOTE: The 0.003 mg/m³ is applicable to the mixture

*Not established/available

SECTION III - PHYSICAL DATA

BOILING POINT DEG F (DEG C): **
VAPOR PRESSURE (torr): 0.088 @ 25 DEG C (calculated)
VAPOR DENSITY (AIR=1): 5.98 (calculated)
SOLUBILITY IN WATER: Data not available
SPECIFIC GRAVITY (H2O=1): **
FREEZING (MELTING) POINT: **
AUTOIGNITION TEMPERATURE DEG F (DEG C): Data not available
VISCOSITY (CENTISTOKES): Data not available
VOLATILITY (mg/m³): 8.22 X 10² at 25 DEG C
EVAPORATION RATE: Data not available
APPEARANCE & ODOR: Oily Liquid with Garlic-like odor

** Information is a trade secret/Confidential and can be obtained from the Manufacturer at the address listed above.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: (METHOD USED): Data not available
FLAMMABILITY LIMITS (% by volume): Data not available
EXTINGUISHING MEDIA: Water, fog, foam, CO₂. Avoid use of extinguishing methods that will splash or spread mustard.
UNUSUAL FIRE & EXPLOSION HAZARDS: Toxic fumes of Hydrogen chloride and Sulfur oxides may be produced in a fire. Unburned agent will exhibit toxic and vesicant properties.
SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving HQ should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, fire-fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where fire-fighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

Skin contact and inhalation of HQ and its vapors must be avoided at all times. Although the fire may destroy most of the HQ, care must be taken to assure that the HQ does not contaminate uncontrolled areas and that the firefighters are adequately protected from physical contact with the agent and agent fumes. Contact can be fatal.

SECTION V - HEALTH HAZARD DATA

NOTE: Where data are not available for HQ, the following Health Hazard and disposal information is taken from HD.

AIRBORNE EXPOSURE LIMIT (AEL): Since HQ contains HD, a carcinogen and mutagen, airborne exposure should be controlled to the lowest feasible limit. No individual should be intentionally exposed to any direct skin or eye contact. The AEL for HD is 0.003 mg/m³ as an 8 hour time weighted average (TWA).

EFFECTS OF OVEREXPOSURE: HQ is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. The rate of detoxification of HQ in the body is very slow and repeated exposure produce a cumulative effect. There are no data available for human toxicity. The toxicity data available for animals follows:

Mouse HQ (75/25) L₅₀ = 770 mg-min/m³

Maximum safe Ct for skin and eyes are 5 and 2 mg-min/m³, respectively.

THE PHYSIOLOGICAL ACTION OF HQ IS CLASSIFIED AS LOCAL AND SYSTEMIC.

LOCALLY, HQ affects both the eyes and the skin. SKIN damage occurs after percutaneous resorption. Being lipid soluble, HQ can be resorbed into all organs. Skin penetration is rapid without skin irritation. Swelling (blisters) and reddening (erythema) of the skin occurs after a latency period of 4-24 hours following the exposure, depending on degree of exposure and individual sensitivity. The skin healing process is very slow. Tender skin, mucous membrane and perspiration covered skin are more sensitive to the effects of HQ. HQ's effect on the skin, however, is less than on the eyes. Local action on the eyes produces severe necrotic damage and loss of eyesight. Exposure of eyes to HQ vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea.

SYSTEMIC ACTIONS occur primarily through inhalation and ingestion. The HQ vapor aerosol is less toxic to the skin or eyes than the liquid form. When inhaled, the upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, loss of appetite, diarrhea, fever, and apathy. Exposure to nearly lethal doses of HQ can produce injury to bone marrow, lymph nodes, and spleen as indicated by a drop in WBC count and, therefore, results in increased susceptibility to local and systemic infections. Ingestion of HQ will produce severe stomach pains, vomiting, and bloody stools after a 15-20 minute latency period.

CHRONIC EXPOSURE to HQ can cause sensitization, chronic lung impairment, (cough, shortness of breath, chest pain), and cancer of the mouth, throat, respiratory tract, skin, and leukemia. It may also cause birth defects.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

EYE CONTACT: Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the patient to a medical facility IMMEDIATELY.

SKIN CONTACT: Don respiratory protection mask and gloves; remove victim from agent source immediately. Flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5 percent sodium hypochlorite solution, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility.

INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable at ambient temperatures. HQ is a persistent agent depending on pH and moisture, and has been known to remain active for up to three years in soil.

INCOMPATIBILITY: Data not available.

HAZARDOUS DECOMPOSITION: HQ will hydrolyze to form HCl, thiodiglycol, and 1,2-bis-(2-chloroethylthio) ethane.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Only personnel in full protective clothing will be allowed in an area where HQ is spilled. HQ should be contained using vermiculite, diatomaceous earth, clay or fine sand and neutralized as soon as possible using copious amounts of STB, slurry or HTH solution. Never use dry STB or HTH since they will react violently with HQ and may burst into flames. Scoop up all contaminated material and place in approved DOT containers. Pour in STB slurry or HTH solution. Decontaminate the outside of the container and overpack with a larger container pouring vermiculite or other absorbent material in between the two drums. Label in accordance with state, DOT and EPA regulations, and hold for disposal. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 3).

NOTE: Surfaces contaminated with HQ and then rinse-decontaminated may evolve sufficient HQ vapor to produce a physiological response.

WASTE DISPOSAL METHOD: All neutralized material should be collected,

contained and thermally decomposed in an EPA permitted incinerator for decontaminated HQ (see note), which will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated protective clothing should be decontaminated using HTH or bleach and analyzed to assure it is free of detectable contamination (3X) level. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the DA issue point. Decontamination of waste or excess material shall be accomplished in accordance with the following procedures.

(a) HQ on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid.

(b) Chemical neutralization of HQ may be accomplished by adding it to an excess of 60/40 slurry of STB or HTH solid bleach and water. HQ has poor solubility in water. The HQ/bleach slurry must be stirred frequently over 24 hours to assure that the HQ has contacted and reacted with the bleach. After 24 hours, test for the presence of active chlorine in the decon slurry before offering for incineration.

Note: Some states consider certain decontaminated surety agents as RCRA hazardous waste. Local regulations must be considered before disposal action is taken.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

*Concentration (mg/m³)

Respiratory Protection/Ensemble Required

Less than or equal
to 0.003 as an
8-hr TWA

- Protective mask not required provided that:
- (a) Continuous real-time monitoring (with alarm capability) is conducted in the work area at the 0.003 mg/m³ level of detection.
 - (b) M9, M17 or M40 mask is available and donned if excursion concentration exceeds 0.003 mg/m³.
 - (c) Exposure has been limited to the extent practicable by engineering controls (remote operations, ventilation, and process isolation) or work practices.

If these conditions are not met then the following applies:

Full facepiece, chemical canister, air-purifying respirators. (The M9, M17, or M40 series or other certified equivalent masks are acceptable for this purpose in conjunction with the M3 toxicological agent protective (TAP) suit for dermal protection.)

Greater than
0.003 as an
8-hr TWA

NIOSH/MSHA approved pressure demand full facepiece SCBA suitable for use in high agent concentrations with protective ensemble (See DA Pam 385-61 for examples)

* Information based on the similarity of HQ to HD.

VENTILATION: Local Exhaust - Mandatory. Must be filtered or scrubbed. Air emissions shall meet local, state and federal regulations.

Special. Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods shall have an inward face velocity of 150 lfpm plus or minus 20%. Laboratory hoods shall be located such that cross drafts do not exceed 20% of inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in assessing the ability of the hood to contain agent HQ.

Other. Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hoods.

PROTECTIVE GLOVES: MANDATORY. Butyl Toxicological Agent protective gloves (M3, M4, or glove set)

EYE PROTECTION: As a minimum, chemical goggles will be worn. For splash hazard use goggles and face-shield.

OTHER PROTECTIVE EQUIPMENT: For general lab work, gloves and lab coat shall be worn with M9, M17, or M40 mask readily available.

In addition, when handling contaminated lab animals, a daily clean smock, foot covers, and head covers are required.

MONITORING: Real Time Analytical Platform (RTAP)

Real-time, low-level monitors (with alarm) are required for HQ operations. In their absence, an IDLH atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

During handling, the "buddy" (two-man) system will be used. Containers should be periodically inspected for leaks, either visually or using a detector kit, and prior to transferring the containers from storage to work areas. Stringent control over all personnel handling HQ must be exercised. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and at the end of the workday. No smoking, eating, or drinking is permitted at the work site. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. HQ should be stored in containers made of glass for Research Development Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-tight containers when in storage. Each worker will shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap before leaving at the end of the work day.

OTHER PRECAUTIONS: For additional information see AR 385-61, "The Army Toxic chemical Agent Safety Program", DA Pam 385-61, "Toxic Chemical Agent Safety Standards", and DA Pam 40-173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT".

SECTION X - TRANSPORTATION DATA

FORBIDDEN FOR TRANSPORT OTHER THAN VIA MILITARY (TECHNICAL ESCORT UNIT)
TRANSPORT AS PER 49 CFR 172

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.

DOT HAZARD CLASSIFICATION: 6.1, Packing Group I, Hazard Zone B

DOT LABEL: Poison

DOT MARKING: Poisonous liquids, n.o.s. (Sulfur Mustard/Sesqui-Mustard)
UN 2810, Inhalation Hazard

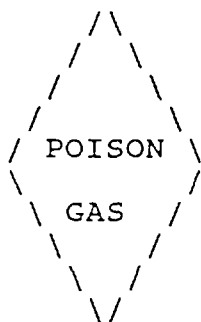
DOT PLACARD: POISON

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted in accordance with AR 740-32.

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See sections IV, VII, and VIII.

While the Edgewood Research, Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research, Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

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REVISED: 30 June 95
DATE: 26 September 1993

U.S. ARMY EDGEWOOD
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER

Emergency Telephone #s:
ERDEC Safety Office
410-671-4411 0700-1700
EST After normal duty
hours: 410-671-2148
Ask for ERDEC Staff
Duty Officer

HT

MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY CHEMICAL AND BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH, DEVELOPMENT AND ENGINEERING
CENTER
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: Not Available

CHEMICAL NAME:

HD : Bis-(2-chloroethyl) sulfide
T : Bis-[2-(2-chloroethylthio)-ethyl] ether

Alternate chemical names:

See components (HD, T)

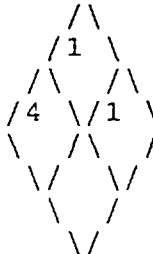
TRADE NAME AND SYNONYMS:

HT
Sulfur - Mustard (Vesicant)

CHEMICAL FAMILY: Chlorinated sulfur compound

FORMULA/CHEMICAL STRUCTURE: Mixture of 60% Sulfur Mustard (HD) and 40%
Sulfur Mustard (T) by weight
HD: C4 H8 Cl2 S
T: C8 H16 Cl2 O S2

CFPA 704 SIGNAL: Health - 4
Flammability - 1
Reactivity - 1



SECTION II - COMPOSITION

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
HT	*	100	0.003 mg/m3

* See Section I

SECTION III - PHYSICAL DATA

BOILING POINT: No constant boiling point. Above 228 DEG C

VAPOR PRESSURE (torr): 0.104 @ 25 DEG C

VAPOR DENSITY (AIR=1): 6.92

SOLUBILITY IN WATER: Practically insoluble.

SPECIFIC GRAVITY (H2O=1): 1.265 at 20 DEG C

FREEZING (MELTING) POINT: 0.0 to 1.3 DEG C

AUTOIGNITION TEMPERATURE DEG F (DEG C): Data not available

VISCOSITY (CENTISTOKES): 6.05 @ 20 DEG C

PERCENTAGE VOLATILE BY VOLUME (mg/m3): 831 @ 25 DEG C

EVAPORATION RATE: Data not available

APPEARANCE & ODOR: Odor: Garlic-like
Appearance: Highly viscous clear to pale yellow liquid

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: (METHOD USED): approximately 100 DEG C (method unknown)

FLAMMABILITY LIMITS (% by volume): Data not available

EXTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid use of extinguishing methods that will splash or spread mustard.

UNUSUAL FIRE & EXPLOSION HAZARDS: May produce hydrogen chloride and sulfur oxides in a fire. Unburned agent vapors may be present and can cause toxic and vesicant effects.

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving HT should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, fire-fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or

chemical accident/incident (CAI) operations officer. In cases where fire-fighters are responding to a chemical accident/incident for rescue/reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMIT (AEL): The AEL for HT is 0.003 mg/m³ as found in DA Pam 40-173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT". No individual should be intentionally exposed to any direct skin or eye contact. The date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for HT.

HD, a component of HT, is recognized as a human carcinogen by the International Agency for Research on Cancer (IARC).

EFFECTS OF OVEREXPOSURE: HT is a vesicant (causing blisters). Since HT contains HD, HT is an alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. The rate of detoxification of HT in the body is very slow and repeated exposure produce a cumulative effect. Median lethal and incapacitating doses of HT in man have not been established. However, the inhalation LC₅₀s in certain animal species have been established as follows:

Dog:	100 - 200 mg-min/m ³
Guinea Pig:	3000 - 6000 mg-min/m ³
Rabbit:	3000 - 6000 mg-min/m ³
Mouse:	820 mg-min/m ³

Maximum safe Ct for HD for skin and eyes are 5 and 2 mg-min/m³, respectively.

ACUTE PHYSIOLOGICAL ACTION OF HT IS CLASSIFIED AS LOCAL AND SYSTEMIC.

LOCALLY, HT affects both the eyes and the skin. SKIN damage occurs after percutaneous resorption. Being lipid soluble, HT can be resorbed into all organs. Skin penetration is rapid without skin irritation. Swelling (blisters) and reddening (erythema) of the skin occurs after a latency period of 4-24 hours following the exposure, depending on the degree of exposure and individual sensitivity. The skin healing process is very slow. Tender skin, mucous membranes, and perspiration covered skin are more sensitive to the effects of HT. HT's effect on the skin, however, is less than on the eyes. Local action on the eyes produces severe necrotic damage and loss of eyesight. Exposure of eyes to HT vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea.

SYSTEMIC ACTIONS occur primarily through inhalation and ingestion. The HT vapor or aerosol is less toxic to the skin or eyes than the liquid form. When inhaled, the upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing and bronchitis, loss of appetite, diarrhea, fever, and apathy. Exposure to nearly lethal doses of HT can produce injury to bone marrow, lymph nodes, and spleen as indicated by a drop in WBC count and, therefore, results in an increased susceptibility to local and systemic infections. Ingestion of HT produce severe stomach pains, vomiting, and bloody stools after a 15-20 minute latency period.

CHRONIC EXPOSURE to HT can cause sensitization, chronic lung impairment,

(cough, shortness of breath, chest pain) and cancer of the mouth, throat, respiratory tract, and skin, and leukemia. It may also cause birth defects.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

EYE CONTACT: Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the victim to the medical facility IMMEDIATELY.

SKIN CONTACT: Don respiratory protection mask and gloves; remove victim from agent source immediately. Flush skin and clothes with 5 percent sodium hypochlorite solution or liquid household bleach, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility IMMEDIATELY.

INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable at ambient temperatures. Decomposition temperature is 165 DEG C to 185 DEG C. HT is a persistent agent depending on pH and moisture, and has been known to remain active for up to three years in soil.

INCOMPATIBILITY: Conditions to avoid. Rapidly corrosive to brass @ 65 DEG C. Will corrode steel at a rate of .0001 in. of steel per month @ 65 DEG C.

HAZARDOUS DECOMPOSITION: HT will hydrolyze to form HCl, thiodiglycol, and bis-(2-(2-hydroxyethylthio) ethyl ether.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Only personnel in full protective clothing will be allowed in an area where HT is spilled (See section 8). In case of personnel contamination see section V "Emergency and First Aid Instructions."

RECOMMENDED FIELD PROCEDURES: Spills of HT must be contained by using vermiculite, diatomaceous earth, clay or fine sand and neutralized as possible using copious amounts of 5.25 percent Sodium Hypochlorite solution. Scoop up all material and place in approved DOT containers. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area

monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

5.25 percent Sodium Hypochlorite solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Calcium Hypochlorite, Decontamination Solution No. 2 (DS2) and Super Tropical Bleach Slurry (STB). WARNING: Pure, undiluted Calcium Hypochlorite (HTH) will burn on contact with liquid blister agent.

RECOMMENDED LABORATORY PROCEDURES: A minimum of 65 grams of decon solution is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 hours, the resulting solution shall be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Place 3 ml of the decontaminate in a test tube. Add several crystals of Potassium Iodine and swirl to dissolve. Add 3 ml of 50 wt percent Sulfuric Acid:water and swirl. IMMEDIATE Iodine color indicates the presence of active chlorine. If negative, add additional 5.25 percent Sodium Hypochlorite solution to the decontamination solution, wait two hours, then test again for active chlorine. Continue procedure until positive chlorine is given by solution.

A 10 wt percent HTH (calcium hypochlorite) mixture may be substituted for Sodium Hypochlorite. Use 65 grams of decon per gram of HT and continue the test as described for Sodium Hypochlorite.

Scoop up all material and place in approved DOT containers. Cover the contents of the drum with decontaminating solution as above. The exterior of drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of the material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (see Section 8).

NOTE: Surfaces contaminated with HT and then rinse-decontaminated may evolve sufficient HT vapor to produce a physiological response.

WASTE DISPOSAL METHOD: All neutralized material should be collected, contained and thermally decomposed in an EPA permitted incinerator for decontaminated HT (see note), which will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated protective clothing should be decontaminated using HTH or bleach and analyzed to assure it is free of detectable contamination (3X) level. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the DA issue point. Decontamination of waste or excess material shall be accomplished in accordance with the following procedure outlined above with the following exception:

--- HT on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid.

Land pit burning or burying of HT or items containing or contaminated with HT in any quantity is prohibited.

Notes: Some states consider certain decontaminated surety agents as RCRA haz-

ardous waste. Local regulations must be considered before disposal action is taken.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

Concentration (mg/m3)	Respiratory Protection/Ensemble Required
Less than or equal to 0.003 as an 8-hr TWA	Protective mask not required provided that: (a) Continuous real-time monitoring (with alarm capability) is conducted in the work area at the 0.003 mg/m3 level of detection. (b) M9, M17 or M40 mask is available and donned if excursion concentrations exceed 0.003 mg/m3. (c) Exposure has been limited to the extent practicable by engineering controls (remote operations, ventilation, and process isolation) or work practices. If these conditions are not met then the following applies: Full facepiece, chemical canister, air-purifying respirators. (The M9, M17, or M40 series or other certified equivalent masks acceptable for this purpose in conjunction with the M3 toxicological agent protective (TAP) suit for dermal protection.)
Greater than 0.003 as an 8-hr TWA	NIOSH/MSHA approved pressure demand full facepiece SCBA suitable for use in high agent concentrations with protective ensemble. (See DA Pam 385-61 for examples).

VENTILATION:

Local Exhaust. Mandatory. Must be filtered or scrubbed. Air emissions shall meet local, state and federal regulations.

Special. Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (1fpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods shall have an inward face velocity by 150 lfpm plus or minus 20%. Laboratory hoods shall be located such that cross drafts do not exceed 20% of inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in assessing the ability of the hood to contain agent HT.

ther. Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hoods.

PROTECTIVE GLOVES: MANDATORY. Butyl Toxicological Agent Protective gloves (M3, M4, gloveset).

PROTECTION: As a minimum, chemical goggles will be worn. For splash hazard use goggles and face-shield.

OTHER PROTECTIVE EQUIPMENT: For general lab work, gloves and lab coat shall be worn with M9, M40 or M17 mask readily available.

In addition, when handling contaminated lab animals, a daily clean smock, foot covers, and head covers are required.

MONITORING: Available monitoring equipment for agent HT is the M8/M9 detector paper, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAMMS), Automated Continuous Air Monitoring System (ACAMS), CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), Miniature Chemical Agent Monitor (MINICAM), and the Real Time Analytical Platform (RTAP).

Real-time, low-level monitors (with alarm) are required for HT operations. In their absence, an IDLH atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING:

During handling, the "buddy" (two-man) system will be used. Containers should be periodically inspected for leaks, either visually or using a detector kit, and prior to transferring the containers from storage to work areas. Stringent control over all personnel handling HT must be exercised. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday. No smoking, eating, or drinking is permitted at the work site. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. HT should be stored in containers made of glass for Research Development Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-tight containers when in storage.

OTHER PRECAUTIONS: For additional information see AR 385-61, "The Army Toxic Chemical Agent Safety Program", DA Pam 385-61, "Toxic Chemical Agent Safety Standards", and DA Pam 40-173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT".

SECTION X - TRANSPORTATION DATA

FORBIDDEN FOR TRANSPORT OTHER THAN VIA MILITARY (TECHNICAL ESCORT UNIT) TRANSPORT AS PER 49 CFR 172

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.

DOT HAZARD CLASSIFICATION: 6.1, Packing Group I, Hazard Zone B

DOT LABEL: Poison

DOT MARKING: Poisonous liquids, n.o.s. (Bis-(2-chloroethyl) sulfide, and Bis-[2-(2-chloroethylthio)-ethyl] ether) UN 2810, Inhalation Hazard

DOT PLACARD: POISON

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted in accordance with AR 740-32.

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See sections IV, VII, and VIII.

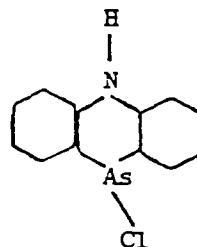
While the Edgewood Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

DM MATERIAL SAFETY DATA SHEET
From CHEMICAL AGENT DATA SHEETS, Vol. I (1974)

1. Chemical Code or EA Number: DM
2. Chemical Name: 10 chloro- 5, 10 dihydrophenarsazine, Adamsite.
3. Chemical Formulae:

a. Empirical. $C_{12}H_9AsClN$

b. Structural.



4. Biological Type Compound: Incapacitating sternutator.
5. Principal Pharmacological Action:

DM produces strong pepper-like local inflammation of the upper respiratory tract, the nasal accessory sinuses, with irritation of the eyes and lacrimation. It causes violent uncontrollable sneezing, coughing, nausea, vomiting, and a general feeling of malaise.

6. Characteristic Odor: No pronounced odor; irritates nasal passages similar to pepper.
7. Effective Routes of Administration: Inhalation, percutaneous, injection, oral.

8. Median Lethal Dosage, Man (LC_{50} 's):

a. Inhalation. (Single exposures of 4 hours or less.)

11,000 mg min/m³ - pure DM dispersed by laboratory methods (as a dry dust, from solvent sprays or by volatilization-condensation).

35,000 mg min/m³ - dispersed from Federal Laboratories No. 113 Spedeheat Grenade.

44,000 mg min/m³ - dispersed from M6A1 military grenade.

Adamsite

9. Median Lethal Dosage, Animal:

a. Inhalation (LC₅₀'s).

<u>Species</u>	<u>Pure DM</u>	<u>M6A1 Grenade</u>	<u>No. 113 Grenade</u>
		mg min/m ³	
Monkey	17,837	19,569	22,814
Dog	7,888	28,193	28,428
Swine	56,364	36,011	35,888
Goat	12,135	8,076	11,723
Rabbit	2,903	41,159	46,959
Rat	19,234	66,856	48,217
Guinea Pig	4,623	12,591	29,888
Mouse	46,245* (1918-1965)		
All rodents	10,951	83,380	37,980
Nonrodents	10,233	24,462	30,063
All species	12,306	43,808	34,683
No. of animals	407	473	656

*These animals are not included in the total number of animals listed below for pure DM.

b. Intraperitoneal. Dog. 10 mg/kg body weight kills a dog.

10. Median Incapacitating Dosage, Man.

a. Inhalation, ICt_{50} : 370 mg min/m³ (nausea and vomiting).

11. Threshold Limit Value: No data.

12. Minimum Effective Dosage, Man:

Lowest intolerable concentration.

<u>Concentration</u>	<u>Time of Exposure</u>
mg min/m ³	minute
22	1
3.6	5
3.45	15
8.40	60

The lowest concentrations (sprayed from alcoholic solutions) that are irritating to the throat and lower respiratory tract are 0.38 and 0.5 mg/m³, respectively. The lowest concentration causing cough is 0.75 mg/m³.

13. Acute Physiological Effects:

a. Single Exposures.

DM produces a feeling of pain and a sense of fullness in the nose and sinuses, accompanied by a severe headache, intense burning in the throat, and tightness and pain in the chest. Irritation of the eyes and lacrimation are produced. Coughing is uncontrollable, sneezing violent and persistent. Nasal secretion is greatly increased, and quantities of ropy saliva flow from the mouth. Nausea and vomiting are prominent. Mental depression may occur during progression of symptoms.

Mild symptoms, caused by exposure to very low concentrations, resemble those of a severe cold. The onset of symptoms may be delayed for several minutes after initial exposure, and effective exposure may, therefore, occur before the presence of the smoke is suspected.

If the mask is then put on, symptoms will increase for several minutes in spite of adequate protection. As a consequence, the victim may believe his mask is ineffective and by removing it cause himself to be further exposed.

Symptoms of exposure to field concentrations usually disappear in 20 minutes to 2 hours, leaving no residual injury. A few instances of severe pulmonary injury and death have occurred due to accidental exposures to high concentrations in confined spaces.

b. Repeated Exposures.

Monkeys, dogs, and guinea pigs were exposed to DM aerosols (No. 113 grenade) on 10 consecutive days. The daily doses were approximately at the LC_{t5} level. A similar group of animals was exposed to approximately the LC_{t20} to 25 level on each of 10 days. In both cases, the accumulated doses would be expected to kill all animals if the total dose were given in a single exposure.

The lower dose level killed five out of eight monkeys. This is more than would be expected from any one of the exposures alone, but less than would be expected from the total accumulated dose. The deaths among the dogs and guinea pigs at the low dose level were less than would have been expected from any of the single exposures and far less than would be expected from the accumulated dose.

The deaths in monkeys and guinea pigs at the high dosage level are slightly greater than that which would have been expected for the greatest single dose. The deaths in dogs were less than would have been expected of the greatest single dose. There was little indication of cumulative toxicity due to the repeated exposures.

14. Chronic Physiological Effects:

a. A survey was made at Edgewood Arsenal of 39 women exposed to various concentrations.

Thirty-one workers who had been subjected to DM dust from 4 to 6 weeks were studied. Most of these workers had become entirely free of the initial eye and nose symptoms. This hardening process took several days to a week and the tolerance was readily lost within several days away from DM. Exposure to a much heavier concentration usually led to a return of symptoms. Epistaxis was observed in two workers after heavy exposures. Chronic hoarseness was present in one-quarter of the patients, burning of the skin in one-third, and hyperpigmentation of the skin in one-third of the subjects studied. Acute dermatitis was present in one-quarter of the patients.

Eight patients with moderately heavy chronic exposure had become tolerant to the action on the respiratory tract except for slight chronic conjunctivitis and persistent hoarseness in a few cases. Posterior cervical lymph node enlargement was noted in two cases and enlargement of the parotid gland in one. The vital capacity was reduced between 40 and 80% of normal in 70%. X-ray of the lungs showed no change attributable to DM exposure.

b. Dermatitis.

By far the most disturbing result of prolonged exposure to DM is the dermatitis which appears in a quarter of the workers so exposed.

(1) Individual variations in tolerance are very large and undoubtedly play a part in the development of dermatitis.

(2) The effect of concentration of DM. Dermatitis may develop in workers exposed to only a very light concentration. Heavy concentrations certainly play a part in the precipitation of frank dermatitis in certain workers.

(3) Effect of moisture and heat. These factors probably increase the sensitivity of the skin and certainly precipitate dermatitis.

(4) Incubation period. Almost every case of dermatitis began three weeks after the beginning of exposure.

(5) Avoidance of DM after dermatitis developed did not result in improvement in the severe cases. In a very mild early case, avoidance of DM was sometimes followed by remission.

(6) Effect of prolonged exposure. Many subjects continued to work with a severe dermatitis. In some of these the dermatitis improved despite continued exposure. In most of the cases the dermatitis persisted.

15. Onset Time of Symptoms: See Items 13 and 14.

16. Self Aid and First Aid:

Put on mask and wear it in spite of coughing, sneezing, salivation, and nausea. Lift the mask from the face briefly if necessary to permit vomiting or to drain saliva from the facepiece. Carry on duties as vigorously as possible; this will help to lessen and shorten the symptoms. Combat duties usually can be performed in spite of the effects of sternutators.

Adamsite

17. Tolerable Environmental Concentrations to Uncontrolled Population:
No data.
18. Molecular Weight: 277.57
19. Purity Range:
 - a. Laboratory Sample. 95 to 99%.
 - b. Plant Sample.
20. Physical Appearance: Light yellow to dark yellow-green solid,
depending on crystal phase.
21. Vapor Density, Relative to Air: 9.6. Does not vaporize at
ordinary temperatures; must be dispersed as an aerosol through application
of heat.
22. Liquid Density: Not applicable.
23. Solid Density:
 - a. Bulk Density. Less than 1 g/cm³.
 - b. Crystal Density. 1.65 g/cm³ @ 20° C.
24. Normal Freezing Point or Melting Point: 195° C.
25. Boiling Point: 410° C with decomposition.
26. Vapor Pressure: 4.5×10^{-11} mm Hg @ 25° C.
27. Volatility: Not of practical significance.
28. Viscosity: NA
29. Flash Point: Does not flash.
30. Autoignition Temperature: Unknown.
31. Latent Heat of Sublimation: 134 cal/g @ 170° to 195° C.
Latent Heat of Vaporization: 80 cal/g @ 200° to 250° C.
32. Latent Heat of Fusion:
33. Vapor-Air Explosive Hazard Range: Not available.

34. Relative Persistency:

- a. Soil. Persistent.
- b. Surface (Wood, Metal, Masonry, Rubber, Paint). Persistent.
- c. Water. Persistent. When material is covered with water, an insoluble film forms which prevents further hydrolysis.

35. Solubility (g/100 g solvent):

- a. Water (distilled). 0.0064 at room temperature.

- b. Other.

Tetrachlorethane	1.16 @ 17° C
Chlorobenzene	1.06 @ 16° C
Benzene	2.3 @ 15° C

- c. Best Solvent.

Acetone	13.03 @ 15° C
---------	---------------

36. Thermal Decomposition Rate (half-life): Not available.

250° C, 0.15% per minute.

37. Heat of Combustion: Unknown.

38. Products of Combustion: Unknown.

39. Rate of Hydrolysis:

- a. Acidic (pH). 0.5% HCl; prevents hydrolysis at room temperature. 0.8% HCl; prevents hydrolysis at 70°C.

- b. Basic (pH). Slowly hydrolyzes in water; see Item 34.

40. Hydrolysis Products: $[\text{NH}(\text{C}_6\text{H}_4)_2\text{AS}]_2\text{O}$ & HCl.

41. Corrosive Properties:

Titanium	71° C, 6 months, appeared good.
Stainless Steel	43° C, 30 days, slight discoloration.
Common Steel	43° C, 30 days, covered with rust.
Aluminum Anodized	43° C, 30 days, minor corrosion & pitting.
Aluminum	43° C, 30 days, severe corrosion.

42. Detection Methods and Equipment: For vapor or solid, M19 kit, DPT test.

43. Decontaminants:

- a. Personnel. Soap and water.
- b. Equipment. Slurry or DS2. Bleaching Powder or DS2 in confined spaces. Aeration is sufficient in the field.
- c. Areas.

Terrain: Earth moving equipment. STB slurry applied by M9 or M12A1 Decontaminating Apparatus.

44. DOT Classification: Irritating Material.

45. Stabilizer Utilized: None.

46. Types of Containers Required for Storage: Heresite
Teflon unaffected, 3 months
Kynar at 71° F.

Stable in steel when pure. After 3 months, caused extensive corrosion of aluminum, anodized aluminum, and stainless steel. Will corrode iron, bronze, and brass when moist.

47. Q-D Classification: 8
Compatibility Group: A
Chemical Group: B

9. Nerve Agents. Nerve agents upset the balance between the sympathetic (adrenergic) and parasympathetic (cholinergic) nervous systems; together, these systems form the autonomic nervous system. Nerve agents react with cholinesterase in an irreversible reaction in tissue fluid to cause accumulation of acetylcholine and continual stimulation of the nervous system.

The nerve agents described in this volume are:

GA or EA 1205 (Tabun)

GB or EA 1208 (Sarin)

GB or EA 1210 (Soman)

VM or EA 1664

VX or EA 1701

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REVISED: 30 June 95
DATE: 18 January 1991

Emergency Telephone #s:
CRDEC Safety Division
410-671-4411 0700-1700
EST After normal duty
hours: 410-671-2148
Ask for ERDEC Staff
Duty Officer

U.S. ARMY EDGEWOOD
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER

POISON

AGENT Q

MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY CHEMICAL AND BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH, DEVELOPMENT AND ENGINEERING
CENTER
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 21010-5423

CAS REGISTRY NUMBER: Not available

CHEMICAL NAME: Bis(B-chloroethylthio)ethane

Alternate chemical names:

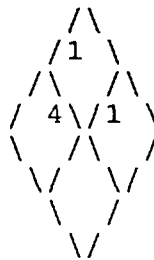
1,2-bis(2-chloroethylmercapto) ethane
1,2-di(chloroethylthio) ethane
Ethylene bis-B-chloroethylsulfide

TRADE NAME AND SYNONYMS:

Q
Sesqui-Mustard

CHEMICAL FAMILY: Chlorinated sulfur compound

NFPA 704 SIGNAL: Health - 4
Flammability - 1
Reactivity - 1



SECTION II - COMPOSITION

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
Q	C6(H12)C12(S2)	100	*

* None established/available

SECTION III - PHYSICAL DATA

BOILING POINT DEG F (DEG C): 194 DEG F (90 DEG C) at 0.02 torr
230 DEG F (110 DEG C) at 0.15 torr
284 DEG F (140 DEG C) at 2.00 torr
358 DEG F (181 DEG C) at 15.00 torr

VAPOR PRESSURE (torr): Solid: 3.5×10^{-5} at 25 DEG C

VAPOR DENSITY (AIR=1): 7.55 (calculated)

SOLUBILITY IN WATER (mg/liter): 25

SPECIFIC GRAVITY (H2O=1): 1.272 at 25 DEG C (extrapolated)

FREEZING (MELTING) POINT: 56 - 57 DEG C

AUTOIGNITION TEMPERATURE DEG F (DEG C): Data not available

VISCOSITY (CENTISTOKES): Data not available

EVAPORATION RATE: Very Slow

APPEARANCE & ODOR: Liquid/Solid - Odor similar to HD which is garlic-like.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: Data not available

FLAMMABILITY LIMITS (% by volume): Data not available

UNUSUAL FIRE & EXPLOSION HAZARDS: Toxic fumes of hydrogen chloride and sulfur dioxide may be present. Unburned agent vapors will exhibit toxic and vesicant properties.

SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving Q should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, fire-fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where fire-fighters are responding to a chemical accident/incident for rescue/reconnaissance purposed vice firefighting, they will wear appropriate levels of protective clothing (see Section 8).

EXTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid use of extinguishing methods that will splash or spread Q.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMIT (AEL): No detailed health hazard data on Q is available. The following information is based upon the limited available information and the chemical similarity to HD. Airborne exposure should be controlled to the lowest feasible limit. No individual should be intentionally exposed to any direct skin or eye contact. The AEL for HD is 0.003 mg/m³ as proposed in the DA Pam 40-173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT".

Q presently is not listed by the International Agency for Research on Cancer (IARC), National Toxicology Program (NTP), Occupational Safety and Health Administration (OSHA), or American Conference of Governmental Industrial Hygienists (ACGIH) as a carcinogen.

EFFECTS OF OVEREXPOSURE: Q is a vesicant (causing blisters). No human data on the effects of Q exist. The median lethal dosages for mice exposed to Q, based upon a 10 minute exposure time, are:

LCt₅₀ (inh) = 250 - 280 mg-min/m³
LCt₅₀ (skin) = 510 - 1500 mg-min/m³

ACUTE PHYSIOLOGICAL ACTION OF Q IS CLASSIFIED AS LOCAL AND SYSTEMIC.

The physiologic action of Q is similar to HD. It has been identified as the most powerful vesicant known, when in contact with the skin, and is highly toxic by inhalation.

*EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

EYE CONTACT: Speed in decontaminating the eyes is absolutely essential. Remove person from the liquid source, flush the eyes immediately with water by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the patient to a medical facility IMMEDIATELY.

SKIN CONTACT: Don respiratory protective mask and gloves; remove victim from agent source immediately. Flush skin and clothes with 5 percent solution of sodium hypochlorite or liquid household bleach within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5 percent sodium hypochlorite solution, then wash contaminated skin area with soap and water. If shower facilities are available, wash thoroughly and transfer to medical facility.

INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

*Based on similarity to mustard (HD)

SECTION VI - REACTIVITY DATA

STABILITY: Stable at ambient temperatures. Decomposition temperature is

approximately 200 DEG C. Q is a persistent agent depending on pH and moisture.

INCOMPATIBILITY: No data is available to indicate the action of Q on metals.

HAZARDOUS DECOMPOSITION: Q will hydrolyze to form HCl and 1,2-Bis-(2-hydroxyethylthio) ethane.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Only personnel in full protective clothing will be allowed in an area where Q is spilled.

*RECOMMENDED FIELD PROCEDURES: The Q should be contained using vermiculite, diatomaceous earth, clay or fine sand and neutralized as soon as possible using copious amounts of 5.25 percent sodium hypochlorite solution. Scoop up all material and place in an approved DOT container. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material used to decontaminate exterior of drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

If 5.25 percent sodium hypochlorite solution is not available then the following decontaminants may be used instead and are listed in the order of preference: calcium hypochlorite, Decontamination Solution No. 2 (DS2), and Super Tropical Bleach Slurry (STB).

*RECOMMENDED LABORATORY PROCEDURES: A minimum of 65 grams of decon solution per gram of Q is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 hours, the resulting solution shall be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color. Place 3 ml of the decontaminate in a test tube. Add several crystals of Potassium Iodine and swirl to dissolve. Add 3 ml of 50 wt percent sulfuric acid: water and swirl. IMMEDIATE iodine color indicates the presence of active chlorine. If negative, add additional 5.25 percent sodium hypochlorite solution to the decontamination solution, wait two hours, then test again for active chlorine. Continue procedure until positive chlorine is given by solution.

A 10 wt percent calcium hypochlorite (HTH) mixture may be substituted for sodium hypochlorite. Use 65 grams of decon per gram of Q and continue the test as described for sodium hypochlorite.

Scoop up all material and place in approved DOT container. Cover the contents of the drum with decontaminating solution as above. The exterior of the drum shall be decontaminated and then labeled IAW EPA and DOT regulations. All leaking containers shall be overpacked with vermiculite placed between the interior and exterior containers. Decontaminate and label IAW EPA and DOT regulations. Dispose of the material IAW waste disposal methods provided below. Dispose of the material used to decontaminate exterior of

drum IAW Federal, state and local regulations. Conduct general area monitoring with an approved monitor (see Section 8) to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (see Sections 2 and 8).

NOTE: Surfaces contaminated with Q and then rinse-decontaminated may evolve sufficient Q vapor to produce a physiological response.

* Information is based on the similarity of Q to mustard (HD).

WASTE DISPOSAL METHOD: All decontaminated material should be collected, contained and chemically decontaminated or thermally decomposed in an EPA approved incinerator, which will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated protective clothing should be decontaminated using calcium hypochlorite (HTH) or bleach and analyzed to assure it is free of detectable contamination (3X) level. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the DA issue point. Decontamination of waste or excess material shall be accomplished in accordance with the procedures outlined above with the following exception:

---- Q on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid.

Open pit burning or burying of Q or items containing or contaminated with Q in any quantity is prohibited.

NOTE: Some states define decontaminated surety materiel as a RCRA hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

*Concentration (mg/m³)

Respiratory Protection/Ensemble Required

Less than or equal
to 0.003 as an
8-hr TWA

Protective mask not required provided that:

- (a) Continuous real-time monitoring (with alarm capability) is conducted in the work area at the 0.003 mg/m³ level of detection.
- (b) M9, M17 or M40 mask is available and donned if excursion concentration exceeds 0.003 mg/m³.
- (c) Exposure has been limited to the extent practicable by engineering controls (remote operations, ventilation, and process isolation) or work practices.

If these conditions are not met then the following applies:

Full facepiece, chemical canister, air-purifying respirators. (The M9, M17, or M40 series or other certified equivalent masks are acceptable for this purpose in conjunction with M3 toxicological agent protective

(TAP) suit for dermal protection.)

Greater than
0.003 as an
8-hr TWA

NIOSH/MSHA approved pressure demand full
facepiece SCBA suitable for use in high
agent concentrations with protective ensemble.
(See DA Pam 385-61 for examples).

* Info based on similarity of Q to sulfur mustard (HD).

VENTILATION: Local exhaust - Mandatory. Must be filtered or scrubbed.
Air emissions shall meet local, state and federal regulations.

Special Ventilation: Laboratory type hoods and other
enclosures should have a face velocity of 100 lfpm plus or
minus 10% with the velocity at any point not deviating from
the average face velocity by more than 20%. Existing labora-
tory hoods shall have an inward face velocity of 150 lfpm plus
or minus 20%. Laboratory hoods shall be located such that
cross drafts do not exceed 20% of the inward face velocity. A
visual performance test utilizing smoke producing devices shall
be performed in assessing the ability of the hood to contain a-
gent Q.

Other. Recirculation of exhaust air from agent areas is prohibited. No con-
nection between agent area and other areas through the ventilation system is
permitted. Emergency backup power is necessary. Hoods should be tested
semi-annually or after modification or maintenance operations. Operations
should be performed 20 cm inside hoods.

PROTECTIVE GLOVES: Mandatory - use butyl toxicological agent protective
gloves (M3, M4, gloveset).

EYE PROTECTION: Chemical goggles. When there is potential for severe ex-
posure (e.g., sampling pressurized system, loading and unloading opera-
tions) chemical goggles and full face shield are recommended.

OTHER PROTECTIVE EQUIPMENT: For general lab work, gloves and lab
coat shall be worn with M9, M17 or M40 mask readily available.

In addition, when handling contaminated lab animals, a daily clean smock,
foot covers, and head covers are required.

MONITORING: Real Time Analytical Platform (RTAP)

Real-time, low-level monitors (with alarm) are required for Q operations.
In their absence, an IDLH atmosphere must be presumed. Laboratory opera-
tions conducted in appropriately maintained and alarmed engineering controls
require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: During handling, the
"buddy" (two-man) system will be used. Containers should be periodically
inspected for leaks, either visually or using a detector kit, and prior to
transferring the containers from storage to work areas. Stringent control
over all personnel handling Q must be exercised. Chemical showers, eyewash
stations, and personal cleanliness facilities must be provided. Each worker

will wash their hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap before leaving at the end of the work day. No smoking, eating, or drinking is permitted at the work site. Decontaminating equipment shall be conveniently ated. Exits must be designed to permit rapid evacuation. Q should be stored in containers made of glass for Research, Development, Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-tight containers when in storage.

OTHER PRECAUTIONS: For additional information see AR 385-61, "The Army Toxic Chemical Agent Safety Program", DA Pam 385-61, "Toxic Chemical Agent Safety Standards", and DA Pam 40-173, "Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, and HT".

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.

DOT HAZARD CLASSIFICATION: 6.1 Packing Group I, Zone B

DOT LABEL: Poison

DOT MARKING: Poisonous liquids, n.o.s. (Bis(B-chloroethylthio) ethane)
UN 2810, Inhalation Hazard

DOT PLACARD: Poison

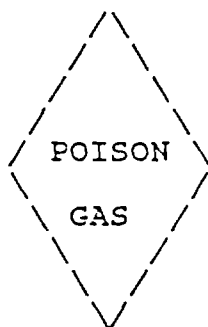
CAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be excorted in accordance with AR 740-32.

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See sections IV, VII, and VIII.

While the Edgewood Research, Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research, Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

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DATE: 26 September 1988



U.S. ARMY CHEMICAL
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER

Emergency Telephone #s:
CRDEC Safety Office
301-671-4411 0800-1630
EST After normal duty
hours: 301-278-5201
Ask for CRDEC Staff
Duty Officer

MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

MANUFACTURER'S NAME: Department of the Army

MANUFACTURER'S ADDRESS: U.S. ARMY ARMAMENT, MUNITIONS, AND CHEMICAL COMMAND
CHEMICAL RESEARCH, DEVELOPMENT AND ENGINEERING
CENTER
ATTN: SMCCR-SFS
ABERDEEN PROVING GROUND, MD 21010-5423

AS REGISTRY NUMBER: Not available

CHEMICAL NAME: Bis-(2-(2-chloroethylthio)ethyl) ether

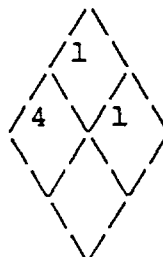
Alternate chemical names: Di(2-(2-chloroethylthio))ethyl ether
Di(2-(B-chloroethyl thio))ethyl ether

TRADE NAME AND SYNONYMS: T
Sulfur Mustard (Vesicant)

CHEMICAL FAMILY: Chlorinated sulfur compound

FORMULA/CHEMICAL STRUCTURE: $[C_1(CH_2)CH_2(SCH_2)CH_2]_2 O$
 $C_8(H_{16})(Cl_2)O(S_2)$

EPA 704 SIGNAL: Health - 4
Flammability - 1
Reactivity - 1



SECTION II - COMPOSITION

INGREDIENTS IE	FORMULA	PERCENTAGE BY WEIGHT	TLV
T	$C_8(H_{16})Cl_2(S_2)O$	100	*

* None established/available

SECTION III - PHYSICAL DATA

BOILING POINT: 120 DEG C at 0.02 torr
174 DEG C at 2.0 torr

VAPOR PRESSURE (torr): 2.9×10^{-5} at 25 DEG C (calculated)

VAPOR DENSITY (AIR=1): 9.08 (calculated)

SOLUBILITY IN WATER: Practically Insoluble

SPECIFIC GRAVITY (H₂O=1): 1.2361 at 25 DEG C

FREEZING (MELTING) POINT: 9.6 to 9.9 DEG C

AUTOIGNITION TEMPERATURE DEG F (DEG C): Data not available

VISCOSITY (CENTISTOKES): 14.7 at 20 DEG C

VOLATILITY (mg/liter): 4.1×10^{-4} at 25 DEG C (calculated)

EVAPORATION RATE: Very Slow

APPEARANCE & ODOR: Clear to Yellowish Liquid - odor like HD (garlic-like)

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: (METHOD USED): Data not available

FLAMMABILITY LIMITS (% by volume): Data not available

EXTINGUISHING MEDIA: Water, fog, foam, CO₂. Avoid use of extinguishing methods that will splash or spread T.

SPECIAL FIRE FIGHTING PROCEDURES: Full protective clothing (see Section III) and full respiratory protection must be worn when fighting fires inside buildings and areas where T agents are stored. Full protective clothing and canister or filter type masks can be worn where oxygen deficiency is not a problem. All persons not engaged in extinguishing the fire should be evacuated. Skin contact and inhalation of T and its vapors must be avoided all times. Although the fire may destroy most of the T, care must be taken to assure that the T does not contaminate uncontrolled areas and that fire fighters are adequately protected from physical contact with the agent and agent fumes. Contact can be fatal.

SECTION V - HEALTH HAZARD DATA

RECOMMENDED EXPOSURE LIMIT: No detailed health hazard data on T is available. The following is based upon the limited available information and the chemical similarity to HD. Airborne exposure should be controlled to the lowest feasible limit. No individual should be intentionally exposed to any direct skin or eye contact or any detectable airborne concentrations.

EFFECTS OF OVEREXPOSURE: T is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues, which are especially sensitive, much the same as for HD. The median lethal and incapacitating doses of T in man have not been established. The median lethal dosage (LCt50) of T in mice is 1650-2250 mg-min/m³, based upon a 10 minute exposure time.

ACUTE PHYSIOLOGICAL ACTION OF T IS CLASSIFIED AS LOCAL AND SYSTEMIC.

LOCALLY, T affects both the eyes and skin. SKIN damage occurs after percutaneous resorption. Being lipid soluble, T can be resorbed into all organs. Skin penetration is rapid without skin irritation. Swelling (blisters) and reddening (erythema) of the skin occurs after a latency period of 4-24 hours following the exposure, depending on the degree of the exposure and individual sensitivity. The skin healing process is very slow. Tender skin, mucous membranes, and perspiration covered skin are more sensitive to the effects of T. T's effect on the skin, however, is less than on the eyes. Local action on the eyes produces severe necrotic damage and loss of eyesight. Exposure of the eyes to T vapors or aerosol produces lacrimation, photophobia, and inflammation of the cornea.

SYSTEMIC ACTIONS occur primarily through inhalation and ingestion. The T vapor or aerosol is less toxic to the skin or eyes than the liquid form. When inhaled, the upper respiratory tract (nose, throat, trachea) is inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, loss of appetite, diarrhea, fever, and apathy. Exposure to nearly lethal doses of T can produce injury to bone marrow, lymph nodes, and spleen as indicated by a drop in WBC count and, therefore, results in increased susceptibility to local and systemic infections. Ingestion of T produce severe stomach pains, vomiting, and bloody stools after a 15-20 minute latency period.

CHRONIC EXPOSURE to T can cause sensitization, chronic lung impairment (cough, shortness of breath, chest pain) and cancer of the mouth, throat, respiratory tract, and skin, and leukemia. It may also cause birth defects.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove from the source IMMEDIATELY. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

EYE CONTACT: IMMEDIATELY flush eyes with water for 10-15 minutes, pulling eyelids apart with fingers and pouring water into eyes. Do not cover eyes with bandages. After flushing eyes with water, protect eyes by use of dark or opaque goggles. Seek medical attention IMMEDIATELY.

SKIN CONTACT: Don respiratory protection mask and gloves; remove victim from source immediately and remove contaminated clothing. IMMEDIATELY decontaminate with liquid household bleach. After 3-4 minutes, wash off with soap and water to remove decon agent and protect against erythema. Seek medical attention IMMEDIATELY.

INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable at ambient temperatures. Decomposition temperature is approximately 180 DEG C. T is a persistent agent depending on pH and moisture.

INCOMPATIBILITY: No data is available to indicate the action of T on metals.

HAZARDOUS DECOMPOSITION: T will hydrolyze to form HCl and di-2-(2-hydroxyethyl thio)ethyl ether.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Only personnel in full protective clothing will be allowed in an area where T is spilled. The T should be contained using vermiculite, diatomaceous earth, clay or fine sand and neutralized as soon as possible using copious amounts of STB, slurry or HTH solution. Never use dry STB or HTH since they will react violently with T and may burst into flames. Scoop up all contaminated material and place in approved DOT containers. Pour in STB slurry or HTH solution. Decontaminate the outside of the containers, label in accordance with state, DOT and EPA regulations, and hold for disposal.

NOTE: Surface contaminated with T and then rinse-decontaminated may evolve sufficient T vapor to produce a physiological response.

WASTE DISPOSAL METHOD: All neutralized material should be collected, contained and thermally decomposed in an EPA permitted incinerator for decontaminated T (see note), which will filter or scrub toxic by-products from effluent air before discharge to the atmosphere. Any contaminated protective clothing should be decontaminated using HTH or bleach and analyzed to assure it is free of detectable contamination (3X) level. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the DA issue point. Decontamination of waste or excess material shall be accomplished in accordance with the following procedure:

(a) T on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid.

(b) Chemical neutralization of T may be accomplished by adding it to an excess of 60/40 slurry of STB or HTH solid bleach and water. T has poor solubility in water. The T/bleach slurry must be stirred frequently over 24 hours to assure that the T has contacted and reacted with the bleach. After 24 hours, test for the presence of active chlorine in the decon slurry before offering for incineration.

NOTE: Some states consider certain decontaminated surety agents as RCRA hazardous waste. Local regulations must be considered before disposal action is taken.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

Concentration (mg/m3)

Respiratory Protection/Ensemble Required

Less than 0.003

M9, M17, or M40 series mask shall be available for escape as necessary.

NOTE: When T concentrations are below the detection limit, but qualitative evidence (i.e. garlic odor or damaged containers) indicates potential vapor exposure, the mask shall be worn.

0.003 to 0.5

M9 or M40 series mask with Level A or Level B ensemble, including impregnated innerwear (see AMCR 385-131 for determination of the appropriate level).

Demilitarization Protective Ensemble (DPE) (30 mil), used with prior approval from the AMC Field Safety Activity. Use time for the 30 mil DPE must be restricted to two hours or less.

Greater than 0.5
or unknown

DPE (30 mil), used with prior approval of the AMC Field Safety Activity. Use time must be restricted to two hours or less.

NOTE: When 30 mil DPE is not available, the M9 or M40 series mask with Level A protective ensemble, including impregnated innerwear, can be used. However, use time shall be restricted to the extent feasible, and may not exceed one hour.

As an additional precaution, the cuffs of the sleeves and the legs of the M3 suit shall be taped to the gloves and boots to reduce aspiration.

VENTILATION:

Local Exhaust - Mandatory. Must be filtered or scrubbed.

Special. Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (100 lfpm) plus or minus 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Laboratory hoods shall be located such that cross drafts do not exceed 20% of inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in assessing the ability of the hood to contain agent T.

General. Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hoods.

EFFECTIVE GLOVES: MANDATORY. Butyl Toxicological Agent Protective gloves (3, 4, or gloveset).

EYE PROTECTION: As a minimum, chemical goggles will be worn. For splash hazard use goggles and face-shield.

OTHER PROTECTIVE EQUIPMENT: Full protective clothing will consist of the M3 butyl rubber suit with hood, M2A1 boots, M3 gloves, impregnated underwear, M9 series mask and coveralls (if desired), or the Demilitarization Protective Ensemble (DPE) if available. For general labwork, gloves and lab coat shall be worn with M9 or M17 mask readily available.

In addition, when handling contaminated lab animals, a daily clean smock, boot covers, and head covers are required.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Voluntary pregnancy testing shall be offered to women who may be exposed to T. During handling, the "Buddy" (two-man) system will be used. Containers should be periodically inspected for leaks, either visually or using a detector kit, and prior to transferring the containers from storage to work areas. Stringent control over all personnel handling T must be exercised. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and at the end of the workday. No smoking, eating, or drinking is permitted at the work site. Decontamination equipment shall be conveniently located. Exits must be designed to permit rapid evacuation. T should be stored in containers made of glass for Research Development Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent shall be double-contained in liquid-tight containers when in storage.

OTHER PRECAUTIONS: See AMC-R 385-131, "Safety Regulations for Chemical Agents H, HD, HT, GB and VX", 9 Oct 1987, for additional information.

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquid, n.o.s.

HAZARD CLASSIFICATION: Poison A

HAZARD LABEL: Poison Gas

HAZARD MARKING: Poisonous liquid, n.o.s. (Sulfur mustard) NA 1955

HAZARD PLACARD: Poisonous Gas

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be required regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents shall be escorted in accordance with AR 740-32.

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV and VIII.

While the Chemical Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Chemical Research Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration,

investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

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U.S. ARMY CHEMICAL
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER

In case of Medical Emergency
Phone Kirk U.S. Army Health
Clinic Emergency Service at
(301) 278-5251/3332

EA 2192

HEALTH HAZARDS DATA WORK SHEET

SECTION II - MATERIAL CHARACTERIZATION

MATERIAL NAME (unless classified) OR CODE: EA 2192

TYPE OF MATERIAL: Nerve

UNIQUE CHARACTERISTICS: Toxic solid

REFRACTORY TO 2-PAM (Anticipated): Yes, not responsive to treatment.

INHALATION HAZARD (Anticipated - Remove patient to a well ventilated area):

Dust = Yes

Vapor = No

EYE HAZARD FROM VAPOR (Anticipated): NO

SKIN PENETRATION HAZARD (Anticipated - Wear gloves, aprons and remove clothing): Poor

ONSET OF SYMPTOMS (Anticipated): Not available

VOLATILITY (Estimated): Low (0 - 100 mg/m3)

MELTING POINT: 138 - 140 DEG C

BOILING POINT: Not available

VAPOR PRESSURE: Not available

DECONTAMINATION:

Personnel: Flush with water, household bleach, or a soap solution wash

Material: Dilute with water, use household bleach

Other: Recommend analysis by NMR to insure complete reaction

RECOMMENDED DISPOSAL PROCEDURES:

Material is designed to have physio-chemical and toxicological properties similar to surety material. It will be detoxified and disposed of IAW procedures for surety materials of a similar class.

SECTION III - TOXICITY

TYPE AGENT: Nerve

RANGE OF POTENCY: **

ONSET OF SYMPTOMS: **

Inhalation Hazard: **

Skin Penetrant Hazard: **

UNIQUE TOXICOLOGIC CHARACTERISTICS (Describe): **

** Presently, data does not exist

SECTION IV - MEDICAL DATA

MATERIAL NAME OR CODE: EA 2192

PHYSICAL FORM: **

RECOMMENDED EMERGENCY MEDICAL TREATMENT: **

Primary Treatment.

For Further Information: Refer to Attached Medical Directive No. _____
from Appendix I to KUSAHC SOP 40-291, 1 April 1988.

Supplemental Information.

RECOMMENDED PERSONNEL DECONTAMINATION PROCEDURE: **

Primary Procedure: Refer to Attached Decontamination Procedure for
ical Exposures, Appendix C to KUSAHC SOP 40-291, 1 April 1988.

Supplemental Personnel Decontamination Information for:

a. Eyes: **

b. Skin: **

c. Other Comments: **

** Presently, data does not exist

HEALTH HAZARDS DATA WORK SHEET

For use of this form, see CRDECR 15-12)

CONTAINS IMPORTANT MEDICAL INFORMATION WHICH MAY AID THE PHYSICIAN IN THE TREATMENT OF THE PATIENT EXPOSED TO EXPERIMENTAL CHEMICAL.

Worker's Name _____
(Print or Type)
Office Phone _____

In Case of Medical Emergency - Phone Kirk U.S. Army Health Clinic Emergency Service at (301) 278-5251 or 278-3332.

SECTION I. PURPOSE:

a. To inform CRDEC laboratory and support personnel of potential health hazards associated with new experimental chemicals early in the developmental process.

b. To provide basic information to assist medical personnel in the delivery of emergency medical services. THERE MAY BE NO INFORMATION ON THIS CHEMICAL AT POISON CONTROL CENTERS.

Specific instructions for completing this work sheet are contained in this regulation (CRDECR 15-18).

SECTION II. MATERIAL CHARACTERIZATION: (To be filled out by the principal investigator (PI) and approved by the proponent branch chief.

CAUTION: The material described below may be highly hazardous/toxic. The information presented here is preliminary, and is considered the best estimate of the characteristics and hazards available at this time. Use precautions appropriate to the type of material as required by specific SOPs.

Material Name (unless classified) or Code EA 2192 S-2-Diisopropyl E
AMINOETHYL METHYLPHOSPHONOTHIOIC ACID

Type of Material (Circle): Nerve Vesicant Blood
Irritant Incapacitant Other _____

_____ : _____ : _____
: : :
Skin Eye Lung Morphine-like Other

Unique Characteristics: (Describe any special hazards or properties; eye/oral, warning properties, etc.) TOXIC SOLID

S-2-Diisopropylaminoethyl methylphosphonothioic acid

SECTION II (continued).

Refractory to 2-PAM (Anticipated):

Yes

No

Inhalation Hazard (Anticipated - Remove patient to a well ventilated area:

DUST = Yes

No = VAPOR

Eye Hazard From Vapor (Anticipated):

Yes

No

Skin Penetration Hazard (Anticipated - Wear gloves, aprons and remove clothing):

Yes

No

Poor

Onset of Symptoms (Anticipated):

Immediate
(0-30 min)Intermediate
(30 min-4 hrs)Delayed
(4-48 hrs)

Volatility (Estimated):

low

0-100 mg/m³

medium

100-4000

high

above 4000

where known: mp 138-140°C bp _____ vp _____

Indicate Use of Following for Decontamination of Personnel:

Flush with Water

Household Bleach (Avoid eyes/mucous membranes)

Other

WASH SOLUTION

Indicate Use of Following for Decontamination of Material:

Dilute with Water

Household Bleach

Other

Recommend analysis by NMIC to insure complete reaction.

RECOMMENDED DISPOSAL PROCEDURES:

X Material is designed to have physio-chemical and toxicological properties similar to surety material. It will be detoxified and disposed of IAW procedures for surety materials of a similar class.

— Material will be detoxified and disposed of as hazardous waste IAW APG Reg 200-2.

Prepared by: HERBERT J. AARON
(Principal Investigator and Branch)

Date 18 JAN 89

Office Location/Symbol 3300 / SMCCR-RSC-0

Phone 3603/414

Approved by: [Signature]
(Chief, Proponent Division)

Date: 18 JAN 89

Office Location/Symbol _____

Phone _____

HEALTH HAZARDS DATA WORK SHEET

SECTION III: TOXICITY (To be completed by the Toxicology Division, Research Directorate, after toxicity screen and/or other toxicological test.)

Security Classification Unclassified

Type Agent (Circle or Identify Appropriate Category):

Nerve Vesicant Blood Incapacitant

Irritant: Eye—Lung—Skin Other No Skin Irritation Observed during Dermal LD50 Tests in Rabb

Range of Potency: LD50 See below ED50 See below LCt50 No Data

Onset of Symptoms:

Immediate (0-30 min) Intermediate (30 min-4 hrs) Delayed (>4 hrs)

Inhalation Hazard: Yes No Comment Not Determined

Skin Penetrant Hazard: Yes No Comment Especially as an alcoholic/aqueous solution.

Unique Toxicologic Characteristics (Describe):

Prepared by: James H. Manthei Date 18 Sept 1990
James H. Manthei
CRDEC, APG-EA 21010-5423

Office Location/Symbol: SMCCR-RST-E Phone 671-2129

Approved by: Harry S. [Signature] Date 18 Sept 1990
(Chief, Toxicology Division)
CRDEC-APG-EA

Office Location: SMCCR-RST Phone 671-3034

Toxicity of EA 2192 (mg/kg)

Rat - oral LD50 - 0.63 (0.51-0.78)

intravenous LD50 - 0.018 (0.017-0.021)

Mouse - intravenous LD50 - 0.050

Rabbit - intravenous LD50 - 0.012

Rabbit - Percutaneous LD50 - 1.14 (0.75-1.74)
(Bare skin)

Percutaneous - Rabbit

ED50 For Tremors - 0.14 (0.03-0.64)

Convulsions - 0.87 (0.60-1.27)

Salivation - 1.28 (0.72-2.2)

Collapse - 1.07 (0.67-1.6)

HEALTH HAZARDS DATA WORK SHEET

SECTION IV: MEDICAL DATA (To be completed by medical representatives of the Experimental Agent Health Hazards Evaluation Committee.)

- A. Material Name or Code: EA 2192
- B. Physical Form: Solid Liquid Vapor Comment LOW VOLATILITY
- C. Recommended Emergency Medical Treatment:

1. Primary Treatment. Treat as NERVE AGENT

For Further Information: Refer to Attached Medical Directive No. I-1, from Appendix I to KUSAHC SOP 40-291, 1 April 1988.

2. Supplemental information: _____

D. Recommended Personnel Decontamination Procedure:

1. Primary Procedure: Refer to Attached Decontamination Procedure for Chemical Exposures, Appendix C to KUSAHC SOP 40-291, 1 April 1988.

2. Supplemental Personnel Decontamination Information For:

- a. Eyes: FLUSH WITH ^{NORMAL} SALINE / WATER
- b. Skin: FLUSH WITH WATER / BLEACH / SOAPY WATER
- c. Other Comments: _____

Prepared by: _____

Commander, KUSAEC

228 3105
PHONE

28 Jun 87
DATE

The following sections of the data work sheet, may be carried by the worker outside the work place (Circle): I II III IV

Approved by: _____

Committee Chairperson

DATE

CONTAINS IMPORTANT MEDICAL INFORMATION WHICH MAY AID THE PHYSICIAN IN THE TREATMENT OF THE PATIENT EXPOSED TO EXPERIMENTAL CHEMICAL.

Worker's Name _____
Print or Type _____
Office Phone _____

In Case of Medical Emergency - Phone Nix U.S. Army Health Clinic Emergency Service at (301) 278-5251 or 278-3332.

SECTION I. PURPOSE:

a. To inform CRDEC laboratory and support personnel of potential health hazards associated with new experimental chemicals early in the developmental process.

b. To provide basic information to assist medical personnel in the delivery of emergency medical services. THERE MAY BE NO INFORMATION ON THIS CHEMICAL AT POISON CONTROL CENTERS.

Specific instructions for completing this work sheet are contained in this regulation (CRDEC 15-13).

SECTION II. MATERIAL CHARACTERIZATION: (To be filled out by the principal investigator (PI) and approved by the proponent branch chief.

CAUTION: The material described below may be highly hazardous/toxic. The information presented here is preliminary, and is considered the best estimate of the characteristics and hazards available at this time. Use precautions appropriate to the type of material as required by specific SOPs.

Material Name (unless classified) or Code EA 2192

Type of Material (Circle): Nerve Vesicant Blood
Irritant Inebriant Other _____

Skin Eye Lung Morphine-like Other

Unique Characteristics: (Describe any special hazards or properties: eye/oral, warning properties, etc.) TOXIC SUDO

SECTION II (continued).

Refractory to C-FLM (Anticipated):

Yes

No

Inhalation Hazard (Anticipated - Remove patient to a well ventilated area:

Yes

No

Eye Hazard From Vapor (Anticipated):

Yes

No

Skin Penetration Hazard (Anticipated - Wear gloves, aprons and remove clothing):

Yes

No

Yes

Onset of Symptoms (Anticipated):

Immediate
(0-30 min)

Intermediate
(30 min-4 hrs)

Delayed
(4-48 hrs)

Volatility (Estimated):

Low

0-100 mmHg

Medium

100-4000

High

above 4000

where known: up to 100 mmHg

Indicate Use of Following for Decontamination of Personnel:

Flush with Water Household Bleach (Avoid eyes, mucous membranes)

Other ~~Household Bleach~~ SOLUTION to ASH

Indicate Use of Following for Decontamination of Material:

Dilute with Water

Household Bleach

Other Permanent Analytic by NPIR to trace complete function.

RECOMMENDED DISPOSAL PROCEDURES:

X Material is designed to have physico-chemical and toxicological properties similar to survey material. It will be detoxified and disposed of IAW procedures for survey materials of a similar class.

— Material will be detoxified and disposed of as hazardous waste IAW AFJ Reg 200-2.

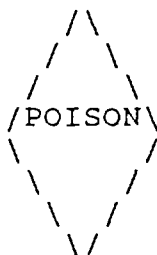
Prepared by: HERBERT J. AARON Date 18 JAN 89
(Principal Investigator and Branch)

Office Location/Symbol 23303 / SMCCR-RSR-0 Phone 2603/414

Approved by: [Signature] Date: 18 JAN 89
(Chief, Proponent Division)

Office Location/Symbol _____ Phone _____

REVISED: 30 June 95
DATE: 1 October 1994



U.S. ARMY EDGEWOOD
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER
MATERIAL SAFETY DATA SHEET

Emergency telephone #'s:
ERDEC Safety Office
410-671-4411/4412 -
0700-1630 EST. After
normal duty hrs. 410-
278-5201. Ask for Staff
Duty Officer

LEWISITE OXIDE

SECTION I - GENERAL INFORMATION

MANUFACTURER'S ADDRESS: U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423

CAS REGISTRY NUMBER: 3088-37-7

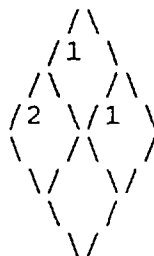
CHEMICAL NAME: 2-Chlorovinylarsine oxide

TRADE NAME AND SYNONYMS: Lewisite oxide
CVAO
Arsine, 2-chlorovinyl oxide
2-chloroethenyl-arsinic oxide
TL88

CHEMICAL FAMILY: Arsenical (vesicant)

FORMULA/CHEMICAL STRUCTURE: $(Cl-CH=CH-As=O)_n$ - Polymer (Crystalline solid)
 C_2H_2AsClO

NFPA 704 SIGNAL: Health - 2
Flammability - 1
Reactivity - 1



SECTION II - HAZARDOUS INGREDIENTS

INGREDIENTS	FORMULA	PERCENTAGE BY WEIGHT	AIRBORNE EXPOSURE LIMIT (AEL)
Lewisite Oxide	C_2H_2AsClO	100 %	0.01 mg/m3

SECTION III - PHYSICAL DATA

VAPOR PRESSURE (torr): Not available

VAPOR DENSITY (AIR=1): Not available

MOLECULAR WEIGHT: 152.4 (RTECS)

SOLUBILITY IN WATER: Poorly soluble in water, slowly hydrolyzes in dilute acid to form hydrated form of 2-chlorovinyl arsenious acid (CVAA)

MELTING POINT: 143 - 146 DEG C

VOLATILITY (mg/m3): Low (0 - 100 mg/m3 - estimated)

APPEARANCE AND ODOR: White powder, no discernible odor.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: N/A.

FLAMMABILITY LIMITS: N/A.

SPECIAL FIRE FIGHTING PROCEDURES: Fires involving lewisite oxide should be contained to prevent contamination of uncontrolled areas. All persons not engaged in extinguishing the fire should be evacuated immediately. Contact with lewisite oxide or its vapors may be fatal. When responding to a fire alarm in buildings or areas containing lewisite oxide, firefighting personnel should wear full firefighter protective clothing. Respiratory protection is required. Positive pressure, full facepiece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is a danger of oxygen deficiency and when directed by the fire chief. In cases where firefighters are responding to a chemical accident/incident for rescue or reconnaissance purposes vice firefighting, they will wear appropriate levels of protective clothing (see section VIII).

UNUSUAL FIRE AND EXPLOSION HAZARDS: None known

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMIT (AEL): An airborne exposure limit of 0.01 mg/m3 for lewisite oxide is based upon the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for elemental arsenic (7440-38-2).

OSHA Permissible exposure limit (PEL) Final: 8 hour time weighted average (TWA), 0.01 mg(As)/m3.

EFFECTS OF OVEREXPOSURE: Lewisite oxide is a mild vesicant (hydrolysis product of Lewisite). Within 30 minutes, 1 to 2 mg of the material (powder) on human skin will result in 1/3 blister and 3/3 redness (results at 10 minutes). Intermediate symptoms (30 minutes to 4 hours) resulting from 35 ug on the arm (man, 45 minutes) are 3/10 blistered burns (area = 16 mm2) and redness (area = 42 mm2) (T = 86 DEG F). Lewisite oxide is an inhalation hazard and a skin penetrant hazard and is presently listed by the ACGIH as a confirmed human carcinogen. The agent is carcinogenic to humans based on epidemiologic studies of, or convincing

clinical evidence in exposed humans.

LD50 (dog, intraperitoneal) = 2 mg/kg

LD50 (rat, intragastric) = 3.08 mg (total dose) (18 hr)

LD50 (G. pig, subcutaneous) = 0.1 mg/kg

LD50 (G. pig, oral) = 2.0 mg/kg

LD50 (rabbit, oral) = 3.0 mg/kg

LD50 (rat, oral) = 15.0 mg/kg

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Material is an inhalation hazard. Wear appropriate protective equipment. If inhaled, seek medical attention IMMEDIATELY.

EYE CONTACT: If material comes in contact with the eyes flush with water or saline solution immediately for 10-15 minutes by tilting the head to the side, pulling eyelids apart with fingers and pouring water or saline slowly into the eyes. Speed in decontaminating the eyes is absolutely essential. Seek medical attention IMMEDIATELY.

SKIN CONTACT: Remove victim from the source immediately and decontaminate affected areas by flushing with soap and water for 3-4 minutes. Seek medical attention IMMEDIATELY.

INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable

HAZARDOUS POLYMERIZATION: None known

HAZARDOUS DECOMPOSITION: On treatment with a base will produce acetylene, sodium salts of arsenic acid (H_3AsO_4).

SECTION VII - SPILL, LEAK AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:

All emergency clean-up personnel must wear Level A protective clothing and a NIOSH approved airline respirator with a 5-15 minute air bottle or self-contained, breathing apparatus (SCBA). Scoop up the spilled powder and place in a fully removable head drum with a polyethylene liner. If spilled on soil, scoop up about one to two inches of the soil beneath the spill and place in the drum. If spilled on concrete or wood, wash down with copious amounts of water and collect the water and place in a drum. After the clean-up operations are completed, the rubber gloves, boots, and apron shall be washed down with copious amounts of water. The wash water will be collected. Residual water shall be absorbed by the commercial pillows or sausages made of polyester absorbent fiber. The absorbent material shall be placed in a drum.

WASTE DISPOSAL METHOD: All drums of lewisite oxide, rinse solution, and

absorbant materials must be disposed of IAW RCRA regulations for ARSENIC D004 waste as specified on 40 CFR 260 et seq. Check the pH of the solution with pH paper, if the pH is greater than 12.5 or less than 2.0, the material must have additional regulatory requirements of disposal as an EPA D002, corrosive waste. Throw the pH paper in the drum with the waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

Respiratory Protective Equipment

For escape purposes only:

A hooded NIOSH approved respirator with a 5-15 minute air bottle to be used only if lewisite oxide escapes engineering controls or is suspected of escaping engineering controls.

VENTILATION:

Local Exhaust: MANDATORY, lewisite oxide must be used under engineering controls, must be filtered (HEPA & charcoal) or scrubbed to limit exit concentration. Air emissions shall meet local, state and federal regulations.

Special: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute + 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods shall have an inward face velocity of 150 linear feet per minute plus or 20%. Laboratory hoods shall be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in the assessment of the inclosure's ability to contain Lewisite-oxide.

Other: Emergency backup power is necessary. Hoods should be tested semi-annually or after modification or maintenance operations. Operations should be performed 20 cm inside hoods. Procedures should be developed for disposal of contaminated filters.

PROTECTIVE GLOVES: Norton, chemical protective glove set
M3 butyl rubber

EYE PROTECTION EQUIPMENT: Safety glasses as a minimum

OTHER PROTECTIVE EQUIPMENT: For laboratory operations, gloves and lab coat will be worn with appropriate respiratory protection readily available.

MONITORING: Sample for Arsenic.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Chemical showers, eye wash stations, and personal cleanliness facilities must be

provided. Wash hands after handling and before meals. The carrying, storage, usage and/or consumption of food, beverages, cosmetics, smoking materials, tobacco products or other products for chewing; or the chewing of such products in all laboratory areas, is prohibited.

Contaminating equipment shall be conveniently located. Exits must be designed to permit rapid evacuation.

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous solids, n.o.s.

DOT HAZARD CLASSIFICATION: 6.1, Packing Group II

DOT LABEL: Poison

DOT MARKING: Poisonous solids, n.o.s (2-chlorovinylarsine oxide) UN2811

DOT PLACARD: Poison

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII, and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Driver shall be given full and complete information regarding shipment and conditions in case of emergency. Shipments on passenger aircraft or rail are limited to 25 kg. Shipments on cargo aircraft are limited to 100 kg. Shipments may be stowed "on deck" or "under deck" on a cargo vessel but must be stowed "on deck" on a passenger vessel.

While the Edgewood Research Development, and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army of Edgewood Research Development, and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

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1. Chemical Code or EA Number: CK
2. Chemical Name: Cyanogen Chloride.
3. Chemical Formulae:
 - a. Empirical. CClN
 - b. Structural. $\text{Cl}-\text{C}\equiv\text{N}$
4. Biological Type Compound: Lethal agent, rapid acting.
5. Principal Pharmacological Action:

Systemic effects similar to those of hydrocyanic acid (AC), which disrupts the oxidative processes of the body by inhibiting the essential enzyme cytochrome oxidase. In addition, CK is a highly effective local irritant on the eyes; upper respiratory tract, and the lungs. Pulmonary edema may develop as a result of the irritant action on the lungs.
6. Characteristic Odor: Pungent odor detectable at 2.5 mg/m^3 (1 ppm).
7. Effective Routes of Administration: Inhalation; highly irritant to eyes and mucous membranes.
8. Median Lethal Dosage, Man (LCt_{50} 's):
 - a. Inhalation. $11,000 \text{ mg min/m}^3$. Exposure time not stated in source material.
 - b. Percutaneous. No data.
 - c. Other. No data.
9. Median Lethal Dosage, Animals:
 - a. Inhalation.

<u>Species</u>	<u>t</u> min	<u>LCt_{50}</u> mg min/m ³
Mouse	0.5	3,000
	1.0	4,200
	3.0	4,200
	10.0	7,500

Cyanogen Chloride

<u>Species</u>	<u>t</u> min	LCt ₅₀ mg min/m ³
Rat	2.0	9,400
	3.0	5,400
	30.0	9,000
Guinea pig	2.0	7,000
	7.5	9,000
	30.0	17,000
Rabbit	2.0	8,000
	7.5	6,000
	30.0	17,000
Dog	1.0	3,800 (nominal concn)
	3.0	4,200 (nominal concn)
	7.5	4,500
	10.0	5,000 (nominal concn)
	30.0	6,000 (nominal concn)
Monkey	1.0	4,400 (nominal concn)
Goat	1.0	4,500
	3.0	6,000
	10.0	7,500

b. Percutaneous. No data.

c. Other.

(1) Intravenous injection.

<u>Species</u>	LD ₅₀ ± (2 S. E.) mg/kg
Dog*	2.97±0.09
Goat*	3.43±0.006
Rabbit*	3.15±0.25
Rabbit**	3.30±0.36

* Anesthetized

** Unanesthetized

Cyanogen Chloride

(2) Stomach Tube Administration. Rat, LD₅₀, approx. 6.0 mg/kg.

10. Median Incapacitating Dosage, Man:
 - a. Inhalation. IC_{t50}: 7,000 mg min/m³. Exposure time not stated in source material.
 - b. Percutaneous. No data.
 - c. Other. No data.
11. Threshold Limit Value: >1.25 mg/m³.
12. Minimum Effective Dose, Man: Minimal concentration detectable eye irritation by 27/27 human subjects within 3 minutes: 12.2 mg/m³.
13. Acute Physiological Effects:
 - a. Initial. Intense irritation of nose, throat and eyes with coughing, tightness in chest and lacrimation.
 - b. Moderate. Dizziness, dyspnea, retching, and involuntary urination and defecation.
 - c. Severe. Convulsions, unconsciousness, and failing respiration.

If above effects are not fatal, signs and symptoms of pulmonary edema may develop.
14. Chronic Physiological Effects: Residual damage to the central nervous system may occur.
15. Onset Time of Symptoms:
 - a. Initial Symptoms. Immediately upon exposure.
 - b. & c. Moderate and Severe. At lethal doses, unconsciousness and death occur within a few minutes. Depending on the degree of exposure, the pulmonary effects may develop immediately or may be delayed until the systemic effects have subsided.

Death or recovery from cyanide effects within minutes. Recovery from lung irritant effects prolonged.

Cyanogen Chloride

16. Self Aid and First Aid:

- a. Put on the mask immediately if any irritation of the eyes, nose, or throat is noticed.
- b. The first emergency therapeutic measure is the inhalation of amyl nitrate. If hydrocyanic acid or cyanogen chloride are no longer present in the atmosphere, two ampules of amyl nitrite should be crushed in the hollow of the hand and held close to the patient's nose. This may be repeated every few minutes until a total of eight ampules have been used. Artificial respiration should be given if respirations have ceased or are feeble. This will also facilitate the inhalation of the amyl nitrite. The artificial respiration must be continued until spontaneous breathing returns or until 10 minutes after the last sign of heart activity. If hydrocyanic acid or cyanogen chloride vapors are still present in the air, and the casualty is not already masked, he must have his mask put on for him. The crushed ampules of amyl nitrite, in the dosages given above, must then be inserted in the region of the eyelenses of the protective mask near the deflector tube openings; make certain after the insertion of amyl nitrite that the seal of the mask around the face is unbroken. Artificial respiration must be instituted on the patient if he is not breathing or if respiration is feeble.

17. Tolerable Environment Concentrations to Uncontrolled Population:
No data.

18. Molecular Weight: 61.48.

19. Purity Range:

- a. Laboratory Sample. 95 - 99%.
- b. Plant Sample.

20. Physical Appearance: Colorless gas or liquid.

21. Vapor Density, Relative to Air: 2.0.

22. Liquid Density: 1.20 g/ml at 10° C.

23. Solid Density:
 - a. Bulk Density. Not applicable.
 - b. Crystal Density. Not applicable.
24. Normal Freezing Point or Melting Point: -6.9° C.
25. Boiling Point: 12.9° C.
26. Vapor Pressure: 1000 mm Hg @ 25° C.
27. Volatility: 2.6×10^6 mg/m³ @ 12.9° C.
28. Viscosity: NA
29. Flash Point: Does not flash.
30. Autoignition Temperature: Nonflammable.
31. Latent Heat of Vaporization: 103 cal/g. This is sufficiently high to provide a satisfactory pancaking effect.
32. Latent Heat of Fusion: 41.8 cal/g.
33. Vapor-Air-Explosive Hazard Range: Not available.
34. Relative Persistency: Relatively nonpersistent.
35. Solubility (g/100 g solvent):
 - a. Water (distilled). 6.9 at 20° C.; will polymerize.
 - b. Other. CK is completely miscible with almost all common organic solvents, i.e., alcohol, ether. Many of the resulting mixtures are unstable.
 - c. Best Solvent: Organic solvents.
36. Thermal Decomposition Rate (half-life): Decomposes above 100° C. CK will stand for 30 days @ 65° C. without excessive decomposition; polymerizes between 40 and 60 days to form (CNCl)₃, a solid. May explode.
37. Heat of Combustion: Not available.

Cyanogen Chloride

38. Products of Combustion: Not available.
39. Rate of Hydrolysis:
- a. Acidic (pH).
pH 6.6 - 7.06, t 1/2 1.6 hr @ 25° C; pH 4 - 6, t 1/2 58 hr @ 40° C.
 - b. Basic (pH).
pH 8, t 1/2 18 hr; at room temperature.
pH 7, t 1/2 130 hr (tap water) at room temperature.
40. Hydrolysis Products:
- a. Acidic (pH). HCl and HOCl.
 - b. Basic (pH). NaCl and NaCNO.
41. Corrosive Properties: No action on metals when stabilized. Attacks many common metals when stored unstabilized. Will polymerize, may explode.
42. Detection Methods and Equipment: M15A2A, M18A2, M19 kits (DB-3 Test, blue band detector tube), M8 Alarm.
43. Decontaminants:
- a. Personnel. None effective.
 - b. Equipment. Aeration in closed spaces. Sodium hydroxide solution or DS2 on material.
 - c. Areas. Terrain: 5% sodium hydroxide solution sprayed from M9 or M12A1 decontaminating apparatus (PDDA).
44. DOT Classification: Poison A.
45. Stabilizer Utilized:
- a. Laboratory Sample. 5% anhydrous, powdered sodium pyrophosphate; propylene oxide; arsenic trichloride.
 - b. Production Sample. Unknown.
46. Types of Containers Required for Storage: Stabilized CK can be stored in steel up to 100° C. without decomposition or corrosion.

Cyanogen Chloride

47. Q-D Classification: 8
Compatibility Group: A
Chemical Group: B

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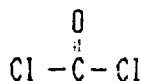
MATERIAL SAFETY DATA SHEET

Sigma-Aldrich Corporation

1001 West Saint Paul Ave. Milwaukee. WI 53233 USA

Version January 1991

	Sigma	Aldrich
For Emergency Contact USA/Canada	800-325-5832	800-231-8327
Outside USA/Canada	314-771-5765	414-273-3850



29,562-8

IDENTIFICATION

PRODUCT #: 29562-0

NAME: PHOSGENE

CAS #: 75-44-5

MF: CCL20

SYNONYMS

CARBON DICHLORIDE OXIDE * CARBONE (OXYCHLORURE DE) (FRENCH) *
 CARBONIC CHLORIDE * CARBONIO (OSSICLORURO DI) (ITALIAN) * CARBON
 OXYCHLORIDE * CARBONYLCHLORID (GERMAN) * CARBONYL CHLORIDE * CARBONYL
 CHLORIDE (DOT.OSHA) * CARBONYL DICHLORIDE * CG * CHLOROFORMYL
 CHLORIDE * FOSGEEN (DUTCH) * FOSGEN (POLISH) * FOSGENE (ITALIAN) *
 KOOLSTOFXYCHLORIDE (DUTCH) * NCI-C60219 * PHOSGEN (GERMAN) *
 PHOSGENE (ACGIH.DOT.OSHA) * RCRA WASTE NUMBER P095 * UN 1076 (DOT) *

TOXICITY HAZARDS

ATECS NO: SY5600000

PHOSGENE

TOXICITY DATA

IHL-HMN LCLO:50 PPM/5M

TABIA2 3,231.33

IHL-HMN LC50:3300 MG/M3

SCJUA3 3(4),33.67

IHL-MAN LCLO:360 MG/M3/30M

85GMAT -.99.82

IHL-RAT LC50:1400 MG/M3/30M

NTIS** PB158-508

IHL-MUS LC50:1800 MG/M3/30M

NTIS** PB158-508

IHL-DOG LC50:4200 MG/M3/20M

NTIS** PB158-508

IHL-MKY LC50:600 MG/M3/1M

NTIS** PB158-508

IHL-RBT LC50:1 GM/M3/30M

NTIS** PB158-508

IHL-GPG LC50:1300 MG/M3/30M

NTIS** PB158-508

IHL-DOM LC50:4600 MG/M3/2M

NTIS** PB158-508

IHL-HOR LC50:10 GM/M3/10M

NTIS** PB158-508

REVIEWS, STANDARDS, AND REGULATIONS

ACGIH TLV-TWA 0.1 PPM 85INAB 5,481.86

MSHA STANDARD-AIR:TWA 0.1 PPM (0.4 MG/M3) DTLVS* 3,208.71

OSHA PEL:8H TWA 0.1 PPM (0.4 MG/M3) FEREAC 54,2923.89

OSHA PEL FINAL:8H TWA 0.1 PPM (0.4 MG/M3) FEREAC 54,2923.89

NIOSH REL TO PHOSGENE-AIR:10H TWA 0.1 PPM;CL 0.2 PPM/15M MMWR** 37(S-7),23,88

NOHS 1974: HZD 57710; NIS 10; TNF 408; NOS 11; TNE 5729

NOES 1983: HZD 57710; NIS 5; TNF 57; NOS 10; TNE 2358; TFE 282

EPA TSCA CHEMICAL INVENTORY, 1989

EPA TSCA SECTION 8(E) STATUS REPORT 8EHQ-0278-0076 P;8EHQ-0278-0079 P

EPA TSCA TEST SUBMISSION (TSCATS) DATA BASE, APRIL 1990

OSHA ANALYTICAL METHOD #ID-61

TARGET ORGAN DATA

LUNGS, THORAX OR RESPIRATION (RESPIRATORY DEPRESSION)

LUNGS, THORAX OR RESPIRATION (OTHER CHANGES)

ONLY SELECTED REGISTRY OF TOXIC EFFECTS OF CHEMICAL

SUBSTANCES (RTECS) DATA IS PRESENTED HERE. SEE ACTUAL

ENTRY IN RTECS FOR COMPLETE INFORMATION.

----- HEALTH HAZARD DATA -----

ACUTE EFFECTS

MAY BE FATAL IF INHALED.

CAUSES BURNS.

MATERIAL IS EXTREMELY DESTRUCTIVE TO TISSUE OF THE MUCOUS MEMBRANES AND UPPER RESPIRATORY TRACT, EYES AND SKIN.

INHALATION MAY BE FATAL AS A RESULT OF SPASM, INFLAMMATION AND EDEMA OF THE LARYNX AND BRONCHI, CHEMICAL PNEUMONITIS AND PULMONARY EDEMA.

SYMPTOMS OF EXPOSURE MAY INCLUDE BURNING SENSATION, COUGHING,

WHEEZING, LARYNGITIS, SHORTNESS OF BREATH, HEADACHE, NAUSEA AND VOMITING.

FIRST AID

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH COPIOUS AMOUNTS OF WATER FOR AT LEAST 15 MINUTES WHILE REMOVING CONTAMINATED CLOTHING AND SHOES.

ASSURE ADEQUATE FLUSHING OF THE EYES BY SEPARATING THE EYELIDS WITH FINGERS.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IF SWALLOWED, WASH OUT MOUTH WITH WATER PROVIDED PERSON IS CONSCIOUS. CALL A PHYSICIAN.

DISCARD CONTAMINATED CLOTHING AND SHOES.

SECTION 3 FOOTNOTES

CAUSES SEVERE DESTRUCTION OF THE ALVEOLAE OF THE LUNGS RESULTING IN PULMONARY EDEMA, SUFFOCATION AND POSSIBLE DEATH. THE ONSET OF THE PULMONARY EDEMA IS DELAYED DUE TO THE SLOW HYDROLYSIS OF THE MATERIAL. LONG TERM EFFECTS ARE EMPHYSEMA, FIBROSIS, COUGHING, BLOODY SPUTUM AND GENERAL MALAISE. THESE SYMPTOMS MAY LAST SEVERAL MONTHS.

----- PHYSICAL DATA -----

VAPOR PRESSURE: 1180 MM @ 20 C

----- FIRE AND EXPLOSION HAZARD DATA -----

EXTINGUISHING MEDIA

USE WATER SPRAY OR FOG NOZZLE TO KEEP CYLINDER COOL. MOVE CYLINDER AWAY FROM FIRE IF THERE IS NO RISK.

• SPECIAL FIREFIGHTING PROCEDURES

WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING TO PREVENT CONTACT WITH SKIN AND EYES.

DANGER: POISONOUS AND CORROSIVE NONFLAMMABLE LIQUID AND GAS UNDER PRESSURE.

UNUSUAL FIRE AND EXPLOSIONS HAZARDS

EMITS TOXIC FUMES UNDER FIRE CONDITIONS.

----- REACTIVITY DATA -----

INCOMPATIBILITIES

WATER
AMINES
AMMONIA
ALCOHOLS
SODIUM
POTASSIUM

HAZARDOUS COMBUSTION OR DECOMPOSITION PRODUCTS

CARBON MONOXIDE, CARBON DIOXIDE
HYDROGEN CHLORIDE GAS

----- SPILL OR LEAK PROCEDURES -----

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

EVACUATE AREA AND KEEP PERSONNEL UPWIND.

WEAR FULL PROTECTIVE EQUIPMENT SUCH AS, A BUTYL RUBBER CHEMICAL-PROOF AIR SUIT, WITH BREATHING AIR SUPPLIED.

SHUT OFF LEAK IF THERE IS NO RISK.

WASTE DISPOSAL METHOD

CAUTION: NO-RETURN CYLINDER. DO NOT REUSE. EMPTY CYLINDER WILL CONTAIN HAZARDOUS RESIDUE. FOLLOW PROPER DISPOSAL TECHNIQUES.

OBSERVE ALL FEDERAL, STATE, AND LOCAL LAWS.

--- PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE ---

CHEMICAL SAFETY GOGGLES.

RUBBER GLOVES.

USE ONLY IN A CHEMICAL FUME HOOD.

NIOSH/MSHA-APPROVED RESPIRATOR IN NONVENTILLATED AREAS AND/OR FOR EXPOSURE ABOVE THE ACGIH TLV.

SAFETY SHOWER AND EYE BATH.

AVOID CONTACT AND INHALATION.

AVOID PROLONGED OR REPEATED EXPOSURE.

WASH THOROUGHLY AFTER HANDLING.

CORROSIVE.

HIGHLY TOXIC.

SEVERE LACHRYMATOR.

COMPRESSED GAS.

CYLINDER TEMPERATURE SHOULD NOT EXCEED 125 F(52 C).

USE WITH EQUIPMENT RATED FOR CYLINDER PRESSURE, AND OF COMPATIBLE MATERIALS OF CONSTRUCTION. CLOSE VALVE WHEN NOT IN USE AND WHEN EMPTY. MAKE SURE CYLINDER IS PROPERLY SECURED WHEN IN USE OR STORED.

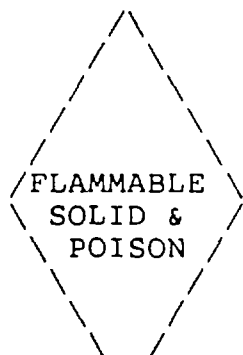
MOISTURE SENSITIVE

WARNING: SUCK-BACK INTO CYLINDER MAY CAUSE RUPTURE.

USE BACK-FLOW-PREVENTIVE DEVICE IN PIPING.

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT BUT DOES NOT PURPORT TO BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. SIGMA-ALDRICH SHALL NOT BE LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT. SEE REVERSE SIDE OF INVOICE OR PACKING SLIP FOR ADDITIONAL TERMS AND CONDITIONS OF SALE

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U.S. ARMY CHEMICAL
RESEARCH, DEVELOPMENT
AND ENGINEERING CENTER

DATE: 8 September 1988

Emergency Telephone #s:
CRDEC Safety Office
301-671-4411 0800-1630
EST After normal duty
hours: 301-278-5201
Ask for CRDEC Staff
Duty Officer

MATERIAL SAFETY DATA SHEET

SECTION I - GENERAL INFORMATION

CAS REGISTRY NUMBER: 6581-06-2

MANUFACTURER'S ADDRESS: U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND
CHEMICAL RESEARCH DEVELOPMENT AND ENGINEERING CENTER
ATTN: SMCCR-SFS
ABERDEEN PROVING GROUND, MD 21010-5423

CHEMICAL NAME AND SYNONYMS:

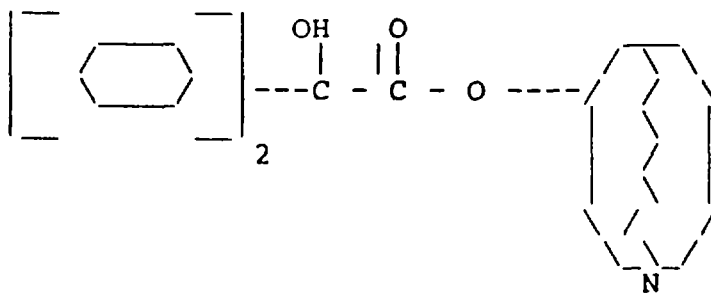
Benzilic Acid, 3-Quinuclidinyl ester
3-Hydroxyquinuclidine benzilate
3-Oxyquinuclidine benzilate
3-Quinuclidinylbenzilate
beta-Quinuclidinyl benzilate

TRADE NAME AND SYNONYMS: BZ, EA2277

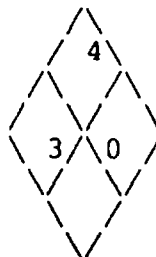
CHEMICAL FAMILY: Glycolate

FORMULA/CHEMICAL STRUCTURE:

C₂₁H₂₃NO₃



NFPA 704 SIGNAL: Health - 3
Flammability- 4
Reactivity- 0



SECTION II - HAZARDOUS INGREDIENTS

INGREDIENTS NAME	FORMULA	PERCENTAGE BY WEIGHT	PEL
BZ	C ₂₁ H ₂₃ NO ₃	100%	PEL: .004mg/m ³ (proposed)

SECTION III - PHYSICAL DATA

BOILING POINT DEG F (DEG C): 774 (412)

VAPOR PRESSURE: Negligible, about 3 X 10⁻⁵ mm Hg @ 70 Deg C

VOLATILITY: .47 mg/m³ @ 70 Deg C

VAPOR DENSITY (AIR=1): 11.6

SOLID DENSITY: Bulk Density - .51 g/cm³
Crystal Density - 1.33 g/cm³

SOLUBILITY: Negligible in water. Complete in halogenated hydrocarbon compounds. Moderate in methanol and ethanol solutions (50 to 70%).

MOLECULAR WEIGHT: 337.4

STABILITY: Resistant to atmospheric degradation. Stable in storage. Thermally stable above its melting point.

MELTING POINT: 167.50 Deg C

APPEARANCE AND ODOR: Beige to white crystalline solid. Odorless.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT (METHOD USED): 246 Deg C - Sublimated sample (McCutchen - Young)
220 Deg C - Process lab sample (McCutchen - Young)

EXPLOSIVE LIMITS: 0.88 to 2.5 grams/ft³

EXTINGUISHING MEDIA: Water, Dry Chemical, CO₂, Halon

SPECIAL FIRE FIGHTING PROCEDURES: Use NIOSH approved pressure-demand SCBA for fire-fighting.

UNUSUAL FIRE AND EXPLOSION HAZARD: BZ is a combustible solid and can form explosive mixtures in air.

SECTION V - HEALTH HAZARD DATA

PERMISSIBLE EXPOSURE LIMIT:

The suggested permissible airborne exposure concentration for BZ for an 8-hour workday or a 40-hour work week is an 8-hour time weighted average (TWA) of 0.004 mg/m³, with a Short Term Exposure Limit (STEL) that should not exceed 0.006 mg/m³ during any 15 minute exposure period, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposure periods. It is further suggested that for the general population, a ceiling airborne exposure concentration of 0.0001 mg/m³ or BZ must not be exceeded at any time. These values are based on the "Interim Design Exposure Acceptable Limits (IDEALS)" for workers at, and general population in the vicinity of BA demil. site, as proposed to Office of the Surgeon General (OTSG) by the USA Environmental Hygiene Agency (USAEHA). To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated permissible exposure concentration for BZ. BZ is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

EFFECTS OF OVEREXPOSURE:

BZ is a very potent psychoactive chemical affecting the central nervous system as well as the organs of circulation, digestion, salivation, sweating and vision. Its pharmacological action is similar to that of other anticholinergic drugs (e.g., atropine, scopolamine, etc.), but longer lasting. Routes of entry into the body include inhalation, oral, skin (with proper solvent) and eye (local).

For man, the inhalation incapacitating dose $ICt_{50} = 101 \text{ mg-min/m}^3$ (at 15 l/min breathing rate) and the IV or IM ID_{50} equal to approximately 5.5 micrograms per kilogram.

For animals, the inhalation LCt_{50} (mouse) 12,00 mg/m³ (t = 5-10 min); for rat 64,000 mg-min/m³ (t = 5-30 min); and for monkey, 37,000 mg/min/m³ (t = 6-25 min). By IV route, LD 50 for mouse, rat, and monkey are 14.1, 14.1 and 10.4 mg/kg respectively. Oral LD 50 (cat) = 50 mg/kg.

Minimum effective dose in man by IV or IM routes = 2.5 - 2.7 ug/kg, producing increased heart rate as well as mild but behaviorally significant reduction of performance capability.

Acute exposure to > 6-8 ug/kg BZ produces both anticholinergic like symptoms (increased heart and respiratory rates; mydriasis; mouth; skin and lip dryness; cycloplegia; high temperature; ataxia; and flushing of face and neck), as well as psychotropic symptoms (hallucination; stupor; forgetfulness; and confusion).

Initial symptoms, after 1/2 to 4 hours of exposure, include dizziness, mouth dryness and increased heart rate. Secondary symptoms, after 3-5 hours of exposure, include restlessness, involuntary muscular movements, rear vision impairment and total incapacitation. Final symptoms, after 6-10 hours of exposure are psychotropic in nature. After 3-4 days, full recovery from BZ intoxication is expected.

*See Addendum A for more detailed information on onset times and symptoms.

data from chronic exposure of animals or man are available.

EMERGENCY AND FIRST AID PROCEDURES:

Because of possible severe heat stroke by any of the following exposure

routes, remove excessive clothing, if environmental temperature is above 70 DEG (21 DEG C). Give fluids only if patient is able to drink unassisted.

INHALATION: Immediately remove from exposure. Seek medical attention immediately. If breathing is irregular or has stopped, start resuscitation and administer oxygen.

EYE CONTACT: Flush eyes with water for at least 15 minutes. Do not rub eyes. Seek medical attention immediately.

SKIN CONTACT: Wash from skin and clothing with water. Remove any contaminated clothing. Seek medical attention IMMEDIATELY.

INGESTION: Seek medical attention IMMEDIATELY. DO NOT induce vomiting.

CAUTION: First aid and medical attention must be given IMMEDIATELY to prevent advancement of effects to a degree that will make the victim difficult to manage.

SECTION VI - REACTIVITY DATA

STABILITY: Stable. Resistance to air oxidation at ambient temperature ($t_{1/2}$ at 25 Deg C & pH 7 = 3-4 weeks). Stable in 0.1N H₂SO₄. Thermally stable in solution ($t_{1/2}$ > 2 hrs at 235 DEG C for pure sample). Stable in glass containers.

CONDITIONS TO AVOID: BZ lightly attacks aluminum and anodized aluminum after three months at 71 DEG C. No effects on steel or stainless steel after three months.

HAZARDOUS DECOMPOSITION PRODUCTS: Pyrolysis occurs at 170 DEG C after prolonged periods yielding CO, CO₂, benzophenone and benzhydrol. Appreciable hydrolysis in acidic or basic solutions occurs yielding 3-quinuclidinol and benzoic acid. BZ is oxidized by hypochlorite at a pH of 1-13.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:

Only personnel in full protective clothing (see Section 8) will be allowed in an area where BZ is spilled or released. Loose BZ will be gathered up and placed in a fully removable head drum. Contaminated surfaces should be washed with .5 to 1 percent non-ionic detergent, 5% acetic acid (only for quantities of BZ less than 1 gram. DO NOT USE FOR LARGER AMOUNTS!), 1 N hydrochloric acid or an organic solvent. Collect all wash solution and place in fully removable head drum. Cover with excess caustic and label in accordance with DOT and EPA requirements. Check solution to ensure the solution is basic and remains basic.

WASTE DISPOSAL METHOD: Open pit burning of BZ or item containing or contaminated with BZ in any quantity is prohibited. BZ shall be disposed of

as follows:

The BZ is only slightly soluble in neutral or alkaline water but is soluble in acidic solutions. It slowly dissolves in alcoholic solutions. Dissolve BZ first in 5% methanol or ethanol. Decontaminate by adding an excess of alcoholic potassium or sodium hydroxide and stir intermittently until in solution. Hydrolysis is complete in 120 min (10 half lives) at pH 12 after the BZ is in solution. It is preferred that the decon bath be allowed to stand 24 hours with occasional stirring. The pH must be checked (not calculated) since the BZ precipitates from basic solution.

The residual solution will be disposed of in accordance with the RCRA regulations for hazardous waste and all applicable state and local regulations.

Alternately, the detoxified waste can be containerized in accordance with DOT requirements and held for pick-up by the US Army Technical Escort Team.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

Concentration
mg/m³

Respiratory Protection

Less than 0.004

Escape respirators shall be available when necessary:

Any NIOSH approved full facepiece respirator with HEPA filters (M9, M17, and M40 series protective masks are also acceptable for this use)

Any NIOSH approved escape SCBA

0.004 - 0.2

Any NIOSH approved full facepiece respirator with HEPA filters (the M9, M17, and M40 series protective masks are also acceptable for this use)

Any NIOSH approved full facepiece pressure-demand SCBA

Any NIOSH approved full facepiece, positive pressure, supplied-air respirator

Greater than 0.2

or
unknown concentrations

Any NIOSH approved full facepiece pressure-demand SCBA

Any NIOSH approved full facepiece, positive pressure, supplied-air respirator with auxiliary SCBA

UTILIZATION:

Local Exhaust: Mandatory, must be filtered or scrubbed to limit the exit concentration to 0.0001 mg/m³.

Special: Chemical laboratory hoods shall have an average inward face velocity of 100 linear feet per minute (lfpm) + or - 10 percent with the velocity at any point not deviating from the average face velocity by more than 20 percent. Laboratory hoods shall be located such that cross drafts do not exceed 20 percent of the inward face velocity. A visual performance test utilizing smoke producing devices shall be performed in assessing the ability of the hood to contain agent BZ.

Hood ventilation systems must be equipped with audio and visual alarms, should the ventilation system fail. Hoods and alarms must be tested semi-annually or after modification or maintenance operations.

Other: BZ operations inside a hood must be performed 20 cm away from face of hood. Exhaust will be to outside of bldg housing the lab. No connection between BZ areas and other areas through ventilation system permitted.

PROTECTIVE GLOVES: Butyl (M3 or M4) or neoprene gloves.

EYE PROTECTION: Protective eye glass (goggle with hooded ventilation) as a minimum.

OTHER PROTECTIVE EQUIPMENT: Maximum protection for non-lab operations will consist of M9 mask and hood, M3 butyl rubber suit, M2A1 butyl boots, M3 or M4 gloves, unimpregnated underwear; or demilitarization protective ensemble (DPE). For specific BZ operations the required level of protective clothing will be determined by the local safety office and will be specified in the local standing operating procedures (SOP). For lab operations, wear lab coats, impervious gloves and have access to a readily available mask. When handling contaminated lab animals, wear daily-clean smock, foot covers, head covers, impervious gloves and lab coats.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: The buddy system will be used during all BZ operations. No smoking, eating, or drinking should be permitted in areas where BZ is being handled. Decontamination equipment must be immediately available. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and at the end of the workday.

Exits must be designed to permit rapid evacuation. Do not store in aluminum or anodized aluminum containers. Storage containers made of most other materials (steel, stainless steel, glass) are satisfactory (storage t1/2 > 1 yr at 71 Deg C).

OTHER PRECAUTIONS: BZ operations will be performed only in areas specifically designated for BZ work. Each employee will be checked for symptoms of BZ exposure before leaving work area. For additional information see AMCR 385-28 "Safety Regulations for Agent BZ".

Employees should be medically evaluated for the following contra-indications prior to being permitted to work with BZ:

Cardiac disease; hypertension; glaucoma; history of reactive airway disease, which may preclude use of particulate respiration.

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Flammable solid, poisonous, n.o.s

DOT HAZARD CLASSIFICATION: Flammable Solid

DOT LABEL: Flammable Solid and Poison

DOT PLACARD: Flammable Solid

DOT MARKING: Flammable solid, poisonous, n.o.s. UN 2926
For export shipments by water, the DOT marking would be
Flammable solid, poisonous, n.o.s. UN 2926 (3-Quinuclidinyl
benzilate)

EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII and VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: All shipments will require Technical Escort in accordance with AR 740-32. See AR50-6 for shipping requirements for BZ.

While the Chemical Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of qualified experts as a warranty or representation for which the Department of the Army or Chemical Research Development and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

THIS MATERIAL SAFETY DATA SHEET IS CURRENTLY BEING REVIEWED BY THE ARMY ENVIRONMENTAL HEALTH AGENCY (AEHA). UPDATED DATA SHEETS WILL BE FORWARDED WHEN THE REVIEW IS COMPLETED.

ADDENDUM A

Onset Time (hrs)	Symptoms
2 - 4	Marked decrease in perception. Loss of responsiveness to visual, auditory, tactile, and painful stimuli.
2 - 6	Nausea, some people vomit. Salivation

	inhibited. Restlessness.
3 - 4	Heart rate increases to 120-150.
3 - 6	Individual attempts to respond to commands but is confused and uncoordinated.
4	Hallucinations and delusions.
4 - 6	Decreased sweating, flushed skin, oral temperature rises to 99-100 DEG in 70 DEG F environment, even higher in warmer environment.
4 - 8	Marked impairment in muscular coordination, cannot dress, walk or eat.
5 - 6	Blood pressure rises to 140/100.
10	Maximum dilation of pupils (8 min). Blurred near vision.
<12	Increased random behavior. As confusion increases, wandering, stumbling, fumbling, undressing, and other poorly organized behavior is seen.
12	Slight decrease in muscular strength during first 12 hrs; urinary retention due to decreased bladder function during first 12 hrs.
>12	Activity level increases and becomes less random, more organized. Shouting, jumping, taking things apart, climbing, conversing with imaginary people.
24 - 36	Individual may succeed in driving cars or firing weapons, but in an indiscriminate and senseless manner. Paranoid thinking may emerge leading to homicidal or suicidal mania.
36 - 96	Duration of incapacitation.